COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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ABSTRACTION OF ATMOSPHERIC NITROGEN*

The two main sources of fixed nitrogen are sulphate of ammonia from gas-works, etc., and sodium nitrate from Chili. The production of the former in Great Britain amounted, in 1910, to about 370,000 tons, and the export of the latter from Chili about two and a half million tons per annum.

Against these figures the output of calcium nitrate and calcium cyanamide, which are two of the main products of the electric fixation of nitrogen processes, seem small. The important thing to notice, however, is that electrical processes are now on a sound commercial footing, and very large extensions of plant have been made recently.

Although the first experimental plant was started only nine years ago, already the company controlling the patents of the direct process of Professor Birkeland and Mr. Sam Eyde for the manufacture of calcium nitrate, have installations aggregating 200,000 horsepower at work.

The other electrically-produced nitrogenous manure, calcium cyanamide, is made by a more indirect method invented by Dr. Franck and Dr. Caro.

The Birkeland-Eyde furnace depends on the inter-action of an alternating-current arc in a constant magnetic field. The furnace, as installed at Notodden, consists of a circular sheet steel drum about 8 feet in diameter and 2 feet wide, lined with refractory fire-brick, and having a disc-like space in the center, 6½ feet diameter and 1¼ inches wide. Air is supplied at the center of the furnace by a Root blower, while a channel round the periphery of

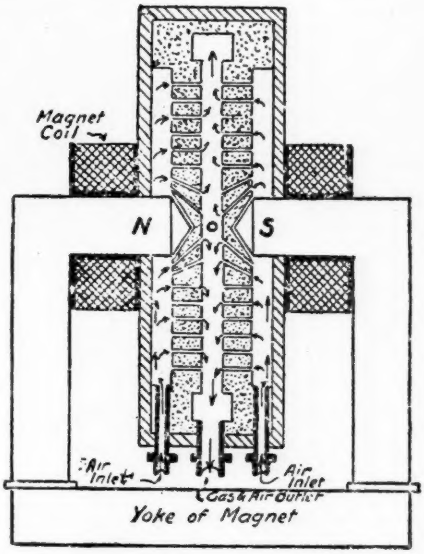


FIG. 1.

the disc space carries off the gases and oxidized air, as shown in Fig. 1.

Two electrodes project into the center of the furnace, and are approached to within about a third of an inch. Surrounding the points of the electrodes there is a magnetic field of about 4,500 lines of force per square centimetre. Alternating current at 5,000 volts and fifty periods per second is supplied to the electrodes, and direct current flows round the coils to produce the magnetic field.

When an arc is struck between the electrodes, it is at once deflected in a direction perpendicular to the lines of force, and the necessity of having alternating current applied to the electrodes will be appreciated from the fact that with direct current the arc would be deflected to one side only. As each

*Ernest Kilbourne Scott, in *Journal of the Royal Society of Arts.*

electrode is alternatively positive and negative, the arc is projected outwards first to one side and then to the other, thus giving a disc of flame about 6 feet in diameter. The speed at which the arc moves outward is extremely rapid, and as the formation of a new arc is practically instantaneous, it appears to the eye as a sheet of flame.

When the extremities of the arc retire along the electrodes, the arc increases in length, its resistance also increasing, until the tension is such that a new arc strikes between the points of the electrodes. The resistance of this short arc being smaller, the tension of the electrodes suddenly sinks to a point that will not sustain the long arc, which is thus extinguished. Another arc starts, and so the process goes on.

As carried out at Notodden, the method of making calcium nitrate is as follows: The nitric oxide gas and air pass from each furnace into two fireproof-lined gas-collecting pipes, about 6 feet in diameter, lined with firebrick. These pipes convey the gas to four steam boilers, the heat given off by the gases being used to raise steam for concentrating the products and for driving the air compressors for pumping acids, soda, etc. The gases then go through tubes in the evaporating tanks, after which the temperature is down to about 250 degrees Centigrade. The temperature is lowered still further, to 50 degrees Centigrade, by passing it through a number of aluminum tubes over which cold water is flowing. The gas then enters the oxidation tanks, which are large vertical iron cylinders, having acid-proof linings. Here it continues to take up oxygen to form nitrogen peroxide, the percentages being now about 98 per cent. air and 2 per cent. nitrogen peroxide.

The nitrogen peroxide is brought into contact with water to form nitric acid, in two series of four towers. These towers are built of granite and are filled with broken quartz, this substance and the granite being chosen because they are not affected by acid. Each tower measures 2 metres square by 10 metres high, and it has been found that they will give an absorption of 3.3 kilograms of nitric acid per cubic metre of space per 24 hours.

The liquid trickles down through the quartz and meeting the nitrogen peroxide gas, combines with it. The liquid moves from tower to tower in the opposite direction to the gas. Thus the fresh water enters at the top of the fourth tower, it flows down through the interstices between the pieces of quartz and falls into a granite tank. From there it is pumped by compressed air to the top of the third tower, down which it trickles into another tank, thence by pumping to the top of the second tower, and so on. When the liquid reaches the bottom of the first tower it contains about 40 per cent. nitric acid. This 40 per cent. solution of nitric acid is sprayed over calcium carbonate, the carbon dioxide gas is driven off and calcium nitrate remains.

The solution is then pumped into solidification pans, under which cold air is circulated to accelerate cooling, and the nitrate of lime stiffens into a brittle, crystalline mass. The mass is then granulated, packed in barrels, and is ready for shipment.

With the Birkeland-Eyde process, one kilowatt-year gives 500 to 550 kilograms of nitrate of lime. The latter usually contains 13 per cent of nitrogen, which corresponds to about 115 kilograms of combined nitrogen.

The problem in the fixation of nitrogen is to raise the temperature as quickly as possible above the igniting point of nitrogen and oxygen, and then immediately to cool the fixed gas and draw it off. The temperature of the burning nitrogen and oxygen flame is lower than the igniting point by about 200 degrees Centigrade. There must be a "hot cold zone," that is, a zone wherein the temperature is enormously high in one part and as low as possible in another part. As the electric arc gives in an easy manner the temperatures above ignition-point it is principally used.

The Rjukan installation is situated in Vestfjorddalen, East Telemarken. The saltpetre factories are situated at Saaheim, and the hydro-electric power-plant on the Maane River, half a kilometre away. The annual production will amount to 70,000 tons of nitrate of lime and 8,000 tons of nitrite.

The furnace invented by Mr. H. Pauling, of Gelsenkirchen, Westphalia, was taken from the idea of the well-known horn-break lightning arrester. As installed at Gelsenkirchen and Innsbruck it consists of two hollow iron electrodes, arranged to form a vee, which at the lowest point is about 4 centimeters across. At this point there are two lighting knives, which can be approached to within a few millimetres, and are readily adjustable. The arc strikes across and runs up the diverging elec-

trodes by reason of the natural convection currents, and the repelling action of its own magnetic field, but principally because of a blast of heated air from an air-duct immediately below. The arc diverges as it follows the shape of the electrodes, and it attains a length of about a yard. At each half-period of the alternating current a fresh arc forms, so that the result is the equivalent of a triangular sheet of flame.

An important feature is that the wall which divides the two parts of the furnace is hollow, and gas and air which has been through the furnace previously and been cooled, is blown through this central passage. This cool gas and air strikes into the top of the arc flame, and it serves to cool the gases which have just been formed. The two arcs are in series, and the furnaces work in sets of three, one to each phase. Each furnace, therefore, receives single-phase current at 6,000 volts, fifty periods per second.

At Gelsenkirchen there are twenty-four such furnaces, each taking 400 kilowatts at 4,000 volts.

The works of La Nitrogène Cie, at La Roche-de-Rame, Hautes Alpes, France, have nine Pauling horn-arrester furnaces of 600 horse-power each in operation, and nine more of 1,000 horse power each are being added.

Some idea of the efficiency of the plant may be obtained from the fact that Mr. Pauling guarantees 60 grams of 100 per cent. HNO_3 per kilowatt-hour of electrical energy, measured at the entrance of the electric transmission line into the factory; and also that the electro-chemical plant proper will cost about 120 francs per kilowatt.

The Southern Electro-Chemical Co. of Nitrolee, South Carolina, has a 4,000 horse-power plant on the Pauling system for manufacture of calcium nitrate. Electric energy is generated in two water-power plants at Great Forks and Rocky Creek.

The discovery of calcium cyanamide came about as the result of a research by Dr. Franck and Dr. Caro, who were following on the lines of some previous work of Playfair and Bunsen. Their immediate object was to make cyanide of potassium for the recovery of gold from tailings, and they incidentally found that barium carbide absorbed nitrogen to form barium cyanamide. By using calcium carbide they obtained a similar reaction. It was then found that by treating calcium cyanamide with hot water it gave off ammonia and this gave rise to the idea of using it as a manure.

As carried out at the Odda Works, the calcium carbide broken into lumps is delivered to crushing machines, from which it passes to mills in which it is ground fine, the whole of these operations being effected automatically in an air-tight plant so as to prevent acetylene gas being given off.

The powder is then filled into electric furnaces, of which, in the first installation at Odda, there are 196, each holding 300 kilograms.

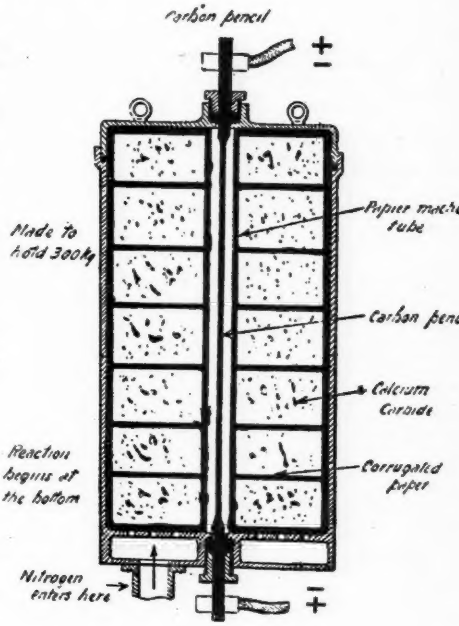


FIG. 2.

Fig. 2 is a rough sketch of the furnace, and it will be noticed that down the center there is a cardboard tube to provide a space for the carbon pencil. After the carbide has been filled in, the carbon pencil is fixed in position and the lid fastened down and made air-tight.

Alternating current is now switched on, and the temperature is raised to 800 to 1000 degress Centigrade. The cardboard tube and certain carboard partitions which had been placed in the furnace when the calcium carbide was run in, are burnt up, and they leave spaces which allow the nitrogen gas, which is admitted under pressure, to circulate freely.

Electric current is kept on for twenty-five hours, and at the end of thirty-five hours all the nitrogen has been absorbed as shown by the meter.

The 196 furnaces make about thirty tons of calcium cyanamide, containing 18 per cent. of nitrogen, per day of twenty-four hours.

When it is turned out of the furnace the cyanamide looks like black clinker. After being broken up it is fed into jaw crushers, and then goes to roulette mills, where it is ground up fine for market.

Although calcium cyanamide is mostly employed as a manure, it has other uses. For example, by treating with superheated steam very pure sulphate of ammonia is obtained. Also the valuable constituents of modern explosives, ammonium nitrate and dicyandiamide, are made from it.

OXY-HYDROGEN POWER

Owing to the phenomenal rate at which the high-speed internal-combustion engine has been introduced, the price of the light oils has so advanced from the value of a waste product to the present price that other means are now being sought to obtain a fuel which may be produced at a greatly reduced cost. In this manner it has been proposed to use alcohol as a substitute for petrol (gasolene) the alcohol being extracted from peat, which in Ireland is so plentiful. Another substitute is now proposed by Mr. G. M. Ironside in the form of oxygen, for this gas, in combination with hydrogen, under pressure yields the greatest energy for a given space yet known, this energy manifesting itself in heat, light, and power, it being only necessary to bring these bodies under pressure to the ignition point to convert to a useful purpose. Recent experiments in the production of hydrogen go to prove that hot air or steam passed through a cylinder containing zinc or iron scrap and dilute sulphuric acid gives off hydrogen, and from the action of water on coke and lime we obtain the same results. Taking these two discoveries as the basis of his own experiments, Mr. Ironside utilized the heat given off from the exhaust of the ordinary type of the internal-combustion engine, passing the hot air over iron filings and dilute sulphuric acid in an acid-proof cylinder, and leading out the hydrogen thus made into a junction pipe running from the oxygen cylinder. The two gases were then run into a mixer and passed out again into the carbureter in the ordinary way, the only change from petrol power being the shutting off of outside air from the carbureter. With coke and lime made hydrogen the engine started cold, and it was found that the power developed was twice that when petrol was used, and the main defect noticed was an increased heating of the cylinder. With regard to the cost of the new power the inexhaustible supply is the surest means of keeping the price of this fuel at a minimum. The most economical mixture of hydrogen to oxygen found by these experiments was stated as one to eight by volume.—*The Practical Engineer*, London.

AVIATORS' SICKNESS

M. Berget, a French aeronaut, has been making a study of aviators' sickness which is different in character and degree from mountain sickness due to the rarefaction of the air in combination with the unusual muscular work of the climber and also from balloon sickness which does not appear except at very high altitudes. The additional and more potent factor in the case of the aviator is the rapidity with which the maximum height is reached and the still greater speed of the descent with the accompanying change of air pressures.

Aeroplanes sometimes reach altitudes of 10,000 feet in an hour, and here the effects on the ear such as humming or cracking noise are about the same as in a balloon, but the effect on the respiratory organs is different. The pilot is sooner out of breath and he feels a special kind of uneasiness. During the descent, the heart beats are of greater amplitude, but without accelerating. A quick descent in a sailing flight at a speed of 1,000 or 1,200 feet a minute or even more, since Morane descended at Havre from 8,000 feet height in 6 minutes, causes a feeling of a special kind, or uneasiness, accompanied with humming in the ears. Burning in the face is also felt and a severe headache, also the great tendency to sleep which has been before observed. The movements of the body are sluggish and unskilful. These symptoms continue for some time after the landing, and the tension in the arteries is noticed to be higher than the normal.

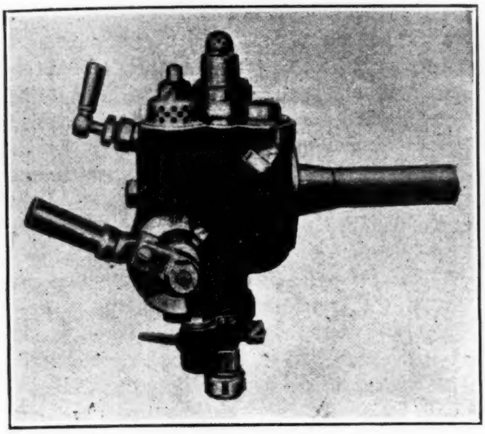


FIG. 1.

A STEAM ACTUATED EJECTOR FOR VACUUM BRAKES

The cuts show the essential features of an ejector used in connection with vacuum brakes made by Davies and Metcalfe, Limited, Rowiley, near Manchester, England. It is of the combined type with features differing from those embodied in similar appliances in general use. Fig. 1 is a general view of the instrument, and Fig. 2 shows the internal arrangements in section. The ejector embraces two separate steam nozzles, one large and the other small, each delivering through an independent orifice into a common exhaust pipe. The smaller nozzle—see the centre drawing in Fig. 2—is constantly in use for maintaining a steady vacuum when running, and the larger is used to obtain a quick release by restoring the vacuum after the application of the brakes.

The nozzles, as will be observed, are of the solid jet type, and are easy of access for inspection or renewal. They are screwed directly into the body of the instrument, and the joints are made steam-tight by means of faced collars. Steam for the nozzles is admitted by means of two separate valves. In the case of the small ejector the valve is direct-acting, with a seating on the end of the nozzle. The steam for the large ejector is controlled by means of a mushroom valve A, shown in the right-hand drawing in Fig. 2, with upper and lower spindles sliding in guides in the ejector casing. The valve is operated by means of a cam on the spindle C, which is connected to the driver's controlling handle D. The upper part of the steam valve chamber is in direct communication with the steam pipe whilst the lower part communicates with the large ejector steam nozzle. On placing the driver's handle in the "brake off" position the steam valve is raised off its seating by the cam, and steam is admitted to the large ejector, and quickly restores the vacuum in the train pipe. In this connection it will be noticed that the steam valve is only operated when the controlling handle is moved to the "brake off" position, and no movement of the valve is caused when the driver's handle is moved from the "running" to the "brake on" position. The steam valve is easily removed for inspection and regrinding by unscrewing the cap shown.

The air admission valve B also is of the mushroom pattern. It has top and bottom guide spindles sliding in guides in the casing, and is op-

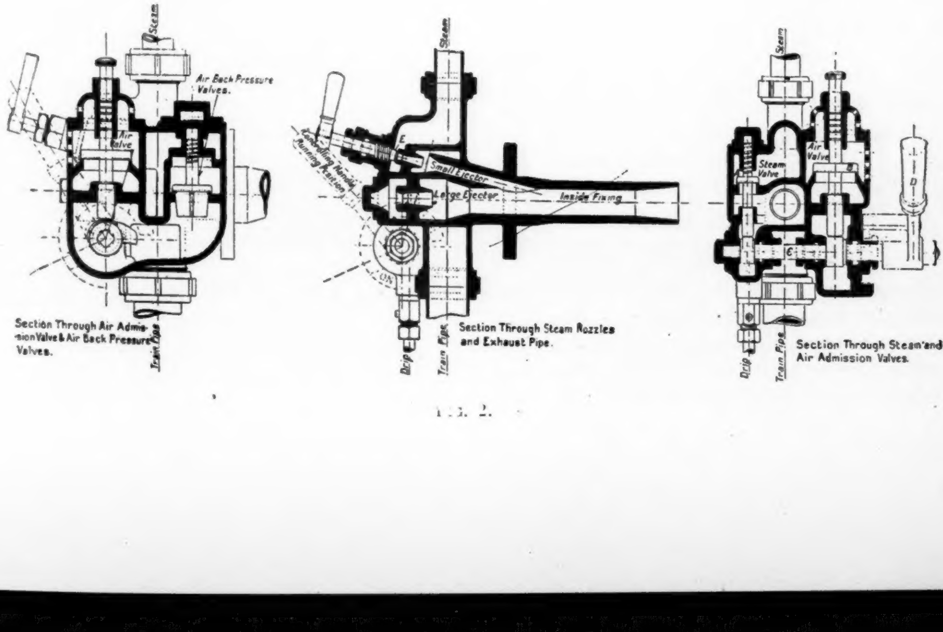


FIG. 2.

erated by a second cam on the spindle C attached to the driver's handle. The chamber above the air valve is open to the atmosphere, while the under side of the valve communicates directly with the train pipe, communication between the upper and lower chamber being controlled by means of the air valve. When the driver's handle is moved to the "brake on" position the cam shaft revolves and the cam raises the valve, allowing air to enter the train pipe. In the "running" and "brake off" positions the valve remains closed. It will be seen that the valve itself only is raised when the handle is moved from the "running" to the "brake on" position and *vice versa.* At all other times it remains at rest, while the rate of admission of air to the train pipe can be regulated. As the steam and air valve chambers are quite separate, the possibility of condensed steam finding its way into the train pipe is reduced to a minimum. To prevent any leakage of air from the ejector chambers to the train pipe the two back-pressure valves shown in the left-hand drawing in Fig. 2 are provided. The large ejector draws air past both these valves, but the small nozzle draws air only past the lower valve. A release valve may also be fitted by means of which, when the brakes are applied, communication between the small ejector and the train pipe is cut off and the small ejector is set to exhaust the air from the engine vacuum chamber only, thus maintaining a vacuum on the top side of the engine brake cylinder.

With a boiler pressure of 160 lb. per square inch the small nozzle has shown itself capable of creating a vacuum of 26½in. mercury, and with both nozzles in use 28in. have been obtained with the barometer standing at 30in. A drop in the boiler pressure to 100 lb. per square inch made a difference of only about 1½in. vacuum. Against an air leakage equivalent to a ½in. diameter hole, and with steam at a pressure of 150 lb., a vacuum of 20in. can be obtained with the large ejector, and 10in. with the small nozzle.—*The Engineer,* London.

GAS METERS DON'T LIE

"I heard a number of people remark that their gas meters worked overtime when the pressure was low, in fact they were supposed to go at a mile a minute clip whenever there was a gas shortage. I didn't want to pay for something I wasn't getting, so I thought I'd find out if this condition was an actual fact. After studying a while, I worked out this plan. I got up early yesterday morning while the pressure was still good before breakfast-getting time, lighted one burner in my gas heating stove and two in my gas range, turned them on full force, then took out my watch and stood by my gas meter until the hand on the upper dial had made one complete revolution. I made a note of the time required for this.

"Then along about noon when the pressure was 'way down, I repeated the performance—lighted the same three burners, one in my heating stove and two in my range, opened them wide and again did sentinel duty by the meter, watch in hand while the hand on the upper dial made one circumference by the circle.

"I was much surprised to note that it took just about three times as long for the meter hand to traverse the same distance in the second instance when the gas was low as when it was merely normal.

"No," smilingly, "I may yell pretty loudly because I am not getting gas at times, but hereafter I'll not think that the gas people are charging me more or that my gas meter is doing a hundred yard dash when the pressure is low, than when it is normal. And I'm sure that if others tried this simple experiment they'd have the same results that I did."

After getting the above story the reporter called on Manager Treleaven, of the local gas company, and asked him if he considered the result of this man's experiment unusual. He replied that it was the only possible result which could have been obtained.

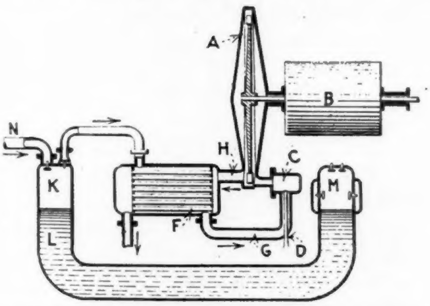
Asked why, in his opinion, there seemed to be such a general belief to the contrary, he stated that it was due to a lack of information on the part of those holding an opposite view.

"There has been a great deal said in times of low pressure," said Mr. Treleaven, "about the meters registering as fast, or even faster, as some would have it, when the pressure was low as under normal conditions. This belief, I think, is merely the result of a failure on the part of those holding this belief to properly inform themselves as to the actual facts. After twenty-five years spent in the gas business, I still have every confidence in the fairness of a great majority of the people—and it has been my experience that where they take a wrong position it is due to lack of information rather

than any intention to be unfair, even though the subject of controversy be a gas meter.

"And I might add that if every customer of ours in Topeka would go to his gas meter when the pressure is low and make a note of the time required for the small hand at the top of the dial to make a complete revolution with a certain number of burners wide open, noting down the result, and then at some later time when the pressure was normal, repeat the operation, being careful that the same burners be used, and that they be wide open, I am sure that it would be hard to find anyone who would still hold to the old belief.

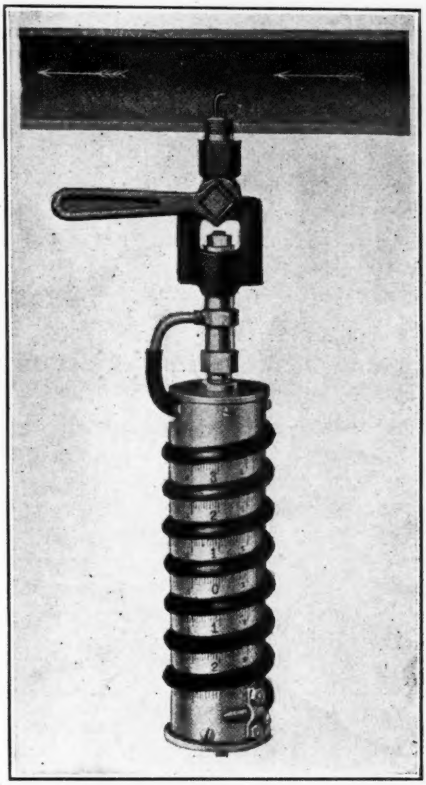
"It would be worth a great deal to our company, not in dollars and cents, but in good will, if all our customers would do this—and I sincerely hope that everyone who might have any intention of raising this question will avail themselves of the opportunity now at hand to find out just what a meter will do under these conditions."—*Topeka Daily Capital.*



COMPRESSED AIR FOR A GAS TURINE

The cut shows the essential features of a gas turbine for which a patent has recently been issued to Brown, Boveri & Co., Baden, Switzerland. In various designs of gas turbines which have preceded this the preliminary compression of air charge for the combustion chamber has been effected by piston or rotating compressors, their employment making the gas turbine as a whole a rather complicated affair. In the arrangement here shown the principle of the Humphrey pump is employed for the necessary air compression.

The gas turbine A is directly connected to an electric generator B. The combustion chamber for the drive of the turbine at C, the fuel entering it by the pipe D and the compressed air by the pipe G. The air comes by the pipe N into the chamber K where it is compressed and is then driven into and through the heater F to the pipe G. The water column L connects chamber K with explosion chamber M, the fluctuations of this water column between the chambers effecting the air compression. The exhaust gases from the turbine leave at part H, and flow in a counter-current through the heater F. The sketch is not drawn to scale, the relative sizes of chambers C and M being especially misleading, but the principle of operation will be understood.



A NEW AIR OR GAS METER

The half tone shows a new Pitot meter for air or gas which gives minutely accurate readings of the flow. It is made by the Sargent Steam Meter Company, Chicago. It is quite small and can be attached to any pipe from ½ inch upward, and being light it may be used either as a permanent or a portable instrument.

It consists of a brass tube or well around the periphery of which is spun a semi-circular helical groove in which is wound a transparent celluloid tube the lower end of which con-

nects with the bottom of the well and the upper end with the Pitot tube. When the handle of the cock is in the vertical position the tube is connected with the atmosphere and then oil is poured into the well until it rises in the tube to the zero mark. Then when the lever is turned to the horizontal position as shown, any pressure from the Pitot tube will cause the oil to rise in the tube and as each coil of the tube is about 10 inches the travel of the oil may be read to indications of hundredths of an inch of the level of the oil in the well. Water may be used instead of oil in the instrument. The well and helix are revolvable on the yoke without disturbing the connections so that the reading is always easy. Any error caused by evaporation or condensation is detected upon turning the cock handle for an instant to the vertical position, when the liquid in the helix should return to zero if conditions have not changed. The meters are tested to 100 inches working pressure.

ONE MAN DRILLS FOR LAKE SUPERIOR MINES

In a valuable series of papers now current in *The Engineering and Mining Journal* Mr. Claude T. Rice discourses as follows:

It may be well to discuss the advances that are going to aid in decreasing the cost at these mines where already mining is surprisingly cheap. There can be no doubt that many economies are going to be affected in Lake Superior mining in the near future, as only lately have the companies commenced in earnest to experiment in regard to supplies, types of rock drills and different methods of doing the operations, using trained men to keep track of the experiments so that the latter will show something definite and their outcome will not be a matter of individual opinion, as so often was the case in the past, when the mine captain had the most to say in regard to underground equipment and practice. Probably the greatest economy that is to come in the near future will be due to the introduction of one-man machines in the stopes. The considerable economy in the cost of breaking the ore that will result in their use is assured by tests that have lasted over a year and it is now only a question of getting the men to use them without any friction arising. Some time must be taken to train the miners to their use, as it is no easy thing for one man to run a machine in these stopes that are from 9 to 20 ft. wide, but probably within two years the two-men drills will be the exception instead of the rule in stoping as well as drifting.

NATURAL GAS COMPRESSION

BY E. D. LELAND.*

The first natural gas compressing station in this country was erected in 1880 by Charles E. Hequembourg of Dunkirk, N. Y., one of the pioneer natural gas engineers. This station of 6,000,000 cu. ft. daily capacity was located at Rixford, Pa., and pumped gas to the city of Bradford through 11 miles of 7 in. cast iron pipe. The first compressor installed was a duplex steam-driven machine with 24 in. steam cylinders, 26 in. gas cylinders, and 30 in. stroke. Later three smaller compressors of the same type were added, and all the machines remained in successful operation until that particular field was exhausted.

Later they were moved to Indiana, where we used them in 1891 for testing pipe-lines, and were ultimately sold for compressing air in the coal mines of Illinois. This is certainly a very creditable record for the earliest natural gas compressor in use.

In 1892, at Greentown, Indiana, we completed the first station designed for compressing large quantities of natural gas to extremely high pressures. The problem was to continuously deliver an adequate supply through two eight inch lines 120 mi. long. In 1892, before the completion of the pipe lines, we used the station machinery to compress the gas into large steel tanks under a pressure of 700 lbs. per sq. in., which were shipped to Chicago. The pipe lines when completed were tested at 600 lb. air pressure and the station was designed for these high pressures. The ordinary delivery pressure was somewhat lower, but the compressors proved amply able to compress gas up to the maximum pressure whenever required, and the installation remained in successful operation during the life of the Indiana gas field. In 1898, because of the decline of the gas field, we resorted to compound compression, using eight units for the first compression, and the other four units on the second compression.

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*Superintendent of Compressing Station, Philadelphia Company, Pittsburgh. From Proceedings of the Engineers' Society of Western Pennsylvania, June, 1912.

As the large quantity of natural gas used each day in Chicago rendered storage capacity for a sufficient reserve supply near the city entirely out of the question, it was most essential that a continuous delivery should be maintained by the pipe lines and compressing station. Hence the installation was planned to consist of 12 straight-line, steam-driven compressor units of moderate size, in order that an accident to any one machine would not seriously affect the delivery capacity of the station. The wisdom of this precaution is manifest when one considers that in 1892 we were just entering the then unknown field of high pressure gas compressing work, and, as there was no one who possessed a fund of experience upon which to draw, many features were necessarily experimental, and machinery troubles were to be expected. Later in the history of gas compressing, engineers felt justified in venturing upon larger and fewer units at any particular station. In fact, as early as 1896, the Fort Wayne Gas Company installed some large cross-compound Corliss engines that were used until the practical exhaustion of the Indiana gas field, and were then sold for use in compressing gas in the Ohio and Kansas gas fields, where they are now running and giving good service.

In planning the modern compressing station the principal facts to be considered are the compressors, the motive power, and the general arrangements tending to promote safety and continuous operation. All of these demand attention, for we must consider the station as a unit and realize that any weakness or defect resulting in a shutdown, defeats the purpose for which the station was built and may cause a gas shortage at a critical time.

A gas compressor is practically an air compressor designed to operate under the high pressure usually required in natural gas transportation. The high pressure compressing experience of nearly 20 years ago soon showed the essentials of reliable compressing machinery, and since that time there has existed no necessity for experimenting in order to obtain reliable compressors, nor has there been any valid excuse for a failure to deliver gas on account of defective machinery.

As an instance of what should now be expected in compressor performance I will cite the record of four compressors installed in 1904, and which have been in almost constant operation ever since. They have been steadily compressing gas to pressures ranging from 200 to 275 lb., and are still operating successfully with the original intake and delivery valves that came with the machines. Furthermore, at no time has a shutdown been caused by valve troubles. Such a record leaves little to be desired from the standpoint of reliable service.

Mechanically driven valves of several types have been tried with varying success, but the grit in the gas and other conditions cause trouble, and experience has shown that the smaller poppet-valve is the most reliable type. The compressor cylinders should, of course, be properly water-jacketed, not alone because such jacketing has some effect in cooling the gas during compression, but also because the water keeps the cylinder walls cool and thus helps the lubrication.

For compressing gas in small quantities or for draining nearly exhausted pools, many types and kinds of compressing machinery have been or are in use. We have the standard, straight-line steam engine driven compressor, usually with the ordinary flat steam valve and Meyer cut-off, the type of machine used for years in air compressing work. We have the straight-line two-cycle, and the straight-line four-cycle, gas engine driven compressor. These machines are easy to erect and the foundations not expensive. We have rotary blowers belted to either steam engines or gas engines, and where it is desired to accelerate the flow of low pressure gas in short lines such blowers may serve a useful purpose. They should not, however, be used against a head of over three or four pounds, as above that point the gas leaking back through the blower prevents good results. In some cases the high speed gas engine connected by rope drive to a slower speed and longer stroke compressor, proves a good arrangement. It not only affords relief from the undesirable features of the short-stroke compressor, but it also makes it feasible to locate the engine at a safe distance from the compressor. While the necessarily quick starting of a gas engine is more liable to cause trouble by breaking the ropes or by throwing them out of their grooves, than is the case with the slower starting steam engine, still with this type of plant fairly good results have obtained with either steam or gas engines and with either the English or American rope drive

system. But, on the whole, in view of the distance advisable between engine and compressor, the American system is to be preferred.

In fact, at unimportant points, almost any type of compressor will prove good enough for the purpose. But for continuous and reliable service in compressing large quantities of gas, the modern cross-compound Corliss engine, directly connected to the compressing cylinders, makes an ideal installation. This engine is particularly well adapted for the long stroke and moderate speed so engineers thoroughly understand that the changing pressure conditions in field and main lines are also well met by the flexibility and high overload capacity of this type of prime mover. So well is this fact recognized that in the stations delivering gas to the Pittsburgh district we find 79 Corliss engine driven compressors installed comprising a total maximum capacity of over 76,000 h. p.

A general idea of the varied pressure conditions encountered in compressing gas will be obtained from the following table, showing the range of delivery pressures at the 13 compressing stations of one gas company in the Pittsburgh district, during a day in February, 1912:

Station No.	6 A. M. lb.	9 A. M. lb.	12 M. lb.	3 P. M. lb.	6 P. M. lb.	12 P. M. lb.
1	1¼	1¼	1¾	1	1¼	1¼
2	6	8	9	4	7½	6
3	11	20	15	14	14	15
4	22	21	10½	20	20	18
5	31½	26	20	16¾	16¼	22¼
6	147	128	119	116	116	129
7	155	127	125	122	124	127
8	172	162	152	148	148	148
9	202	210	197	190	189	187
10	250	245	230	224	222	218
11	273	279	275	282	268	262
12	267	280	280	279	275	260
13	325	337	340	335	338	315

Pressures are not only different at different stations, but at each station the intake and delivery pressures are subject to constant change. This occurs from hour to hour and from day to day, and it follows that the horsepower required at any given station varies as these changing conditions influence the ratio of compression. The maximum load occurs at the highest delivery pressure, with the compression ratio at 3:1, or slightly over, and as the ratio changes to above or below this point the work decreases. But, of course, the engine installed must be large enough to carry the peak load, notwithstanding the fact that very few, if any, gas compressing stations operate at their maximum horsepower more than a small proportion of the time.

ST. PAUL AIR LIFT WELLS

The following is abstracted from the report of L. W. Rundlett, superintendent of construction of the Board of Water Commissioners, St. Paul, Minn.

The equipment at St. Paul consists of 6 standard No. 12 Harris 20th Century pumps with 10-in. well taps, adjusting valves and separators giving 733 gal. each per minute; 6 towers 27 ft. to 28 ft. high upon which are mounted 5 by 6 ft. tanks; 1 Ingersoll-Rand, Class O C, compressor with compound steam cylinders, 18 and 34 by 27, compound air cylinders, 18¼ and 30¼ by 27, and 1 500-sq. ft. Wheeler surface condenser and air pump. The plant is installed at the McCarron Lake Station and is intended for summer operation to augment the lake supply.

About a year ago it became evident on account of the unusual conditions of rainfall last year (the total precipitation being a little more than 10 in.), that there was great danger of exhausting our water supply from the lake system, particularly so should the same conditions extend over another year. Means were taken to utilize our lake supply to the fullest extent and after giving careful consideration to available sources for additional supply, it was finally decided to put down a system of artesian wells at the McCarron Lake Pumping Station. The location at this point at the end of the conduit line and at the pumping station seemed the most favorable.

There being no time to make a preliminary boring, a contract was let at once to sink 6 12-in. wells to such depth as might be necessary to obtain a supply of water. Five of these wells were sunk to a depth of 700 ft., and one well to a depth of 1000 ft., in the hopes of increasing the amount of water, but it was found that the increase in depth did not warrant the expenditure in the other wells. The water rose to an average level of about 18 ft. below the surface. A test was made on 2 wells and showed an excellent supply of water, both in quantity and quality. A contract was then let for the pumping plant. Under the existing conditions, it seemed expedient to place a separate unit at each well and to deliver the water through a pipe system to the terminal chamber where it could be used on both high and low service.

Bids were received for installing an air plant or an electric plant, each bidder guaran-

teeing the efficiency of the plant. Robinson, Cary & Sands Company was awarded the contract for installing an air plant. By the terms of the contract, the addition to the power house for the compressor and an additional boiler were installed by the Board of Water Commissioners. All the physical conditions developed almost exactly in accordance with our anticipations, and the plant is now in successful operation. Under the terms of the test, the Board was to furnish steam to the compressor at 125 lb. pressure. The amount of steam used was determined by the measurement of the condensed water. The heat units of the steam consumed less the heat units of the condensate multiplied by the foot pounds in a pound of steam were to be considered the power furnished. The number of pounds of water pumped multiplied by the height water was raised were to be considered the work done. The amount of work done divided by the power furnished determined the efficiency, which was guaranteed to be not less than 48.3 per cent. with a penalty of $100.00 for every one-tenth of 1 per cent. below this standard and a bonus of $100.00 for every one-tenth above this standard.

The result of the test was as follows:

Duration of test from 8 A. M. to 5 P. M.	9 hours
Average r.p.m. of compressor	80.26
Average steam pressure gage lb. per sq. in	126.4
Average vacuum referred to 30 in. barometer	26.9 in.
Total pounds of condensed water	35,651
Average temperature of condensate	101.5 deg. F.
B.t.u. per pound of steam at average pressure	1189.7
B.t.u. per pound of condensate	69.1
B.t.u. consumed	1120.6
Average cubic feet water per second over weir 6,350,000 gallons per day	9.78
Average total head in feet	76.83
Total foot pounds water delivered ÷ Total foot pounds steam consumed; efficiency	4.90%
Efficiency covered by contract	4.83%

The test was made using the new 78-in. boiler. No effort was bade to run a boiler test, as it would not figure in the results. The total amount of coal consumed was 4947 lb. This would be equivalent to about 6.6 tons on a 24-hr. run. In starting the test, the first hour 617 lb. were burned on the grate, while the last 2 hr. there was an average of only 344 lb. used. I am very confident that as the firemen become accustomed to the boiler and with careful firing, the plant can be run on 5 tons of coal a day, which, at a cost of $5.00 per ton, would amount to $25.00. I should estimate that $10.00 per day ought to cover all other running expenses, making a total cost of about $35.00 per day. Certainly an excellent showing for the conditions of work.

McCarron Lake Station well plant Air Lifts. In operation from June 12, to November 29, 1911:

Total gallons pumped in 1911	885,528,224
Total pounds coal consumed	1,811,461
Ashes, clinker, etc.	153.395
Total pounds of coal consumed (combustible)	1,658.066
Percentage of ash in coal	8.47%
Gallons pumped per pound of coal (actual)	488.8
Gallons pumped per pound of coal (combustible)	534.4
Average duty in foot pounds per 100 lb. coal	31,445.500

Coal for changing boilers deducted in above.

In the record of the official test run at the McCarron Lake Station in July, 1911, the total lift allowed was the necessary head to flow the water into the receiving basin, or 76.83 ft. the actual lift from the surface of the water in the wells when pumping to point of discharge was 81.725 ft., as shown by record below:

Record Test at St. Paul, Minn., July, 1911

Well Nos.	1	2	3	4	5	6
Diameter in.	10	10	10	10	10	10
Depth ft.	700	1000	700	700	700	700
Static head ft.	19	20	12	20	19	19
Drop ft.	28.6	33.35	41.35	33.35	34.35	34.35
Elevation ft.	30	29	30	29	29	30
Total lift ft.	77.6	82.35	83.35	82.35	82.35	83.35
Submergence ft.	146.4	140.65	140.65	140.65	140.65	140.65
100% ft.	224	223	224	223	223	224

Average lift	81.87 ft.
Average submergence	141.61
Percentage of submergence	63%
R.p.m. Compressor	80.26
Pressure on receiver	72
Indicated horsepower	239.7
Gallons per minute pumped	4401
Theoretical horsepower	90.98
Efficiency	38%

NOTES ON SAND BLAST APPARATUS

BY H. V. HAIGHT

It has recently been my privilege to visit a number of foundries and see several sand-blast plants in operation. A few notes on the equipment, its operation and results may be of interest.

Of the two best rooms seen, one was lined with steel plate, the other with plank. The first used heavy plate, about 12 gage, and was substantial and durable in appearance.

The second room was lined with heavy plank set on end behind cleats. The idea, of course, being that if any of the planks should be cut out by the blast they could easily be removed and replaced by new ones.

There is a great difference in the cleanness of different sand-blast rooms. Some are no more dirty than the average foundry and a visitor, wearing a helmet to protect the head

from flying particles, can walk about without discomfort. Others are extremely dusty, the air not only being filled with flying sand, but also with dust and dirt when the blast is in operation, presenting conditions which must be far from healthful.

The second room mentioned above was provided with a slot in the ceiling closed by a door, arranged to allow the crane to drop heavy pieces within the inclosure. In the floor was a grating. The ceiling was made double and there was a bottom exhaust. At this plant the superintendent stated that he changed the workmen every four or five months, believing that long service tends to physical injury. Working for a long period, say five years, in such a place would, he thought, bring on consumption in the case of the average man.

THE USE OF AIR HELMETS

Inquiries were made as to the use of the air helmet; that is, compressed air piped to the helmet worn by the men with the idea that the escaping air will prevent dust from entering. One superintendent recommended the air helmet, although they had never tried it. In another plant these helmets were stated to be objectionable, it being claimed that their use tended to give the operator asthma and head troubles. At still another plant it was said that the hose connection would be so troublesome that the men would not use them. At none of the plants were helmets in use or to be seen.

SAND-BLAST REQUIREMENTS

A common air pressure used in sand blasting is from 40 to 45 lb. per sq. in., although with one system a pressure of 190 lb. is used. A sand consumption of 800 lb. of sand per day of 10 hr. per room was recorded on cleaning steel truck frames and bolster castings. The consumption per casting is about 18½ lb., with an air consumption of 300 cu.ft. of free air per minute per room. At this foundry the fine dust is separated from the sand and the separation seems to be extremely satisfactory. The air is changed 4.87 times per minute with a horsepower expenditure of 7½ hp. per room.

Each room is lighted by incandescent lamps inclosed in wire screens of about 16 mesh.

The nozzles last from one to two days. In another foundry malleable-iron nozzles are used and, while some of these will last as long as three weeks, the cost is about 3c. each.

The sand in most general use was a coarse beach sand. The grains being from 1-32 to 1-16 in. diameter. In the complete systems the sand is automatically returned to the supply hopper, either by a bucket elevator or by fan suction. The dust is also separated from the sand and discharged, often into a standard gondola car. The sand is thus used over and over until it is reduced to a powder with hardly a trace of grit.

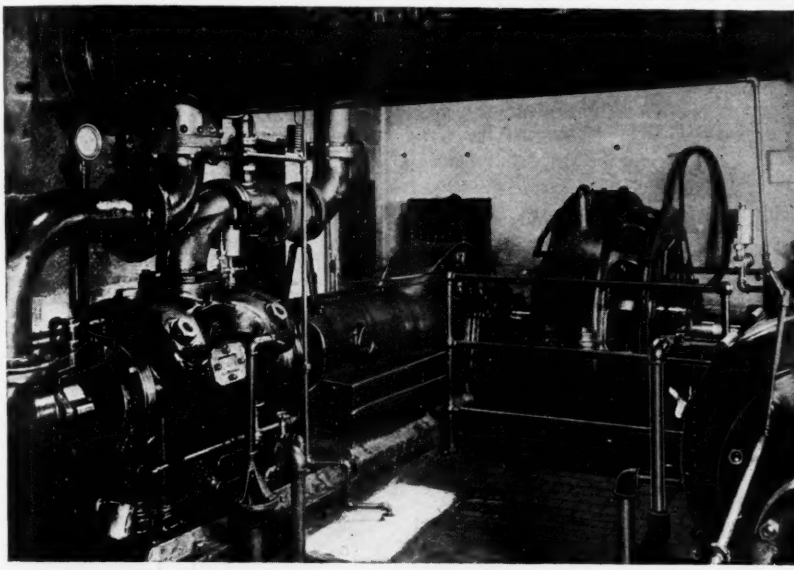
As a general conclusion only complete systems seem successful. All of those which were anything less than complete were intolerably dirty.

USED AS A CLEANING PROCESS

For large work which must be cleaned from sand, as the frames or bases of machines which contain oil for bath or splash lubrication, it seems necessary to use the sand blast as the cleaning process. Where sand burns on, forming a scale, the sand blast seems to be the only practical way to remove positively all the sand.

The above applies to large castings. On the smaller ones the same principle holds, and I believe that the only way to thoroughly remove sand and scale from small castings on which much machine work is to be done is the sand blast. It is true that a cleaning mill pounds down a certain part of the scale and burnishes it, while a sand blast removes scale and has a tendency to show up imperfections. In a general way then the cleaning mill is more suitable for finishing surfaces that are not to be machined and a sand blast for surfaces that are to be finished.

On castings that are to be machined, on automatic and semi-automatic turret lathes, the ideal way would seem to be to first put the casting through the cleaning mill to remove the sand and give a good surface on the parts that are to be left unfinished. Then take it into the sand-blast room and go over the surfaces that are to be machined to remove thoroughly all sand not shaken loose by the cleaning mill and finally blow out all remaining dirt in cored holes and inside pockets. For sand blasting small castings, the best way from the operator's standpoint, is to put them in a sand-blast cleaning mill.—*American Machinist.*



MOTOR-DRIVEN AIR COMPRESSOR UNIT AT THE PARK PLANT OF THE CRUCIBLE STEEL CO. OF AMERICA.

ELECTRICALLY DRIVEN AIR COMPRESSOR FOR SHOP SERVICE

The half tone shows a direct motor driven air compressor installed in the Park works, Pittsburgh, of the Crucible Steel Company of America. It is a two-stage, Class P E 2, compressor of the Ingersoll-Rand Company, with the low pressure cylinder 20¼ in. in diameter and the high pressure 12¼ in., with a common stroke of 18 in. At the rated speed of 180 revolutions per minute the piston displacement is 1,117 cubic feet of free air per minute. Both cylinders have the Hurricane inlet valve and cushioned direct lift discharge valves. The intercooler is set transversely above the air cylinders forming with the vertical pipes a direct connection from the one to the other. The normal delivery pressure is 100 lb. gage, and this is maintained automatically by the governor upon the air intake of the low pressure cylinder.

The air is taken from the compressor to a large air receiver outside the compressor room and from this it is piped to different parts of the works, for hoisting, for operating pneumatic tools, etc.

The motor driving this compressor was manufactured by the Westinghouse Electric & Mfg. Co., and has a capacity of 210 horsepower at 200 revolutions per minute. It is mounted between the high and low pressure sides of the compressor and is designed for operation on direct current circuits at 220 volts. It is of the constant speed type, compound wound, and is equipped with commutating poles. The frame is cast steel and the air spaces are provided in the windings. The motor is controlled by a multiple switch starter mounted on a slate panel. It can be stopped instantly by a push button, which opens the automatic switch or circuit-breaker on the panel. The outfit operates 24 hours a day with the exception of the time between the shifts which is taken for cleaning and inspection.

The commutating poles insure a sparkless commutation at all loads with the brushes remaining at one position. Due to the open type of construction employed, excellent ventilation is assured and air is permitted to reach the windings. The direct-connected compressor results in the saving of power due to the elimination of intermediary transmission.

During the calendar year 1911 the mines on the Witwatersrand gold fields purchased rubber hose for conveying compressed air to rock drills to the value of $334,839.

AN AUTOMATIC ELECTRICALLY OPERATED AIR ADMISSION AND EXHAUST VALVE

BY A. S. WILLIAMSON.*

In the operation of a piece of special apparatus in the mechanical laboratory of the University of Illinois, it is necessary that certain heavily weighted levers be alternately raised and lowered by means of a vertical air cylinder and piston. The flow of air is automatically controlled by an electrically operated valve of somewhat novel design.

An electrically operated unbalanced slide or piston valve requires for its operation considerable force acting through a distance equal to the travel of the valve from admission to exhaust position. If a return spring is used for motion in one direction, this force must be doubled. If poppet valves operated directly by magnets be used, the lifting power of the magnets must exceed the pressure multiplied by the area of the valve seat, and this force must act through a distance equal to the desired lift of the valve. Either design is entirely feasible, but it was desired to avoid the use of powerful solenoids or magnets and the valve shown in the figure was designed to operate with current from one or two dry cells.

In continuous operation, with direct exhaust and consequent quick lowering of the weighted levers referred to, the pipe cap and nipple shown at D, Fig. 1, are removed. The operation is such that, when the electric circuit is open air flows to the cylinders and raises the weighted levers. When, in the operation of the machine, a commutator closes the circuit through the electric bell magnet M, the flow of air is interrupted and the exhaust opened. In the first case, compressed air entering at A raises the plug C, which closes the rubber backed exhaust valve D, and air flows through port FG to the cylinder, raising the weights. Armature P is counterbalanced and as the circuit is open, pin valve N is free to rise and leakage past plug C escapes through port E.

As port C is but 1-16 in. in diameter only a slight external pressure on valve N is required to overcome the air pressure which tends to raise it, and when the circuit is closed by the commutator, magnet M pulls armature P down

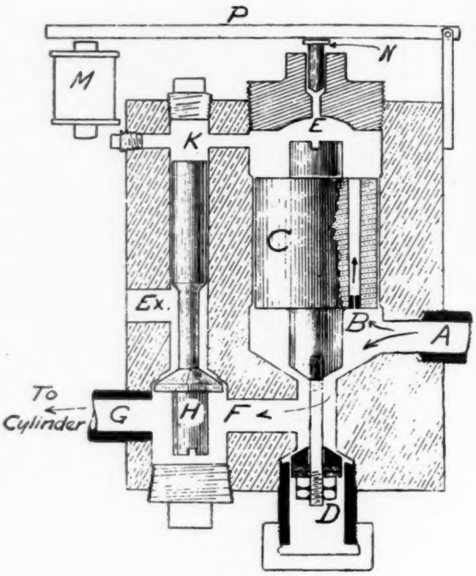


FIG. 1.

closing valve N. Air leaking around plug C and passing through choke plug B quickly accumulates over plug C, which drops both by virtue of its weight and of the now unbalanced pressure on valve D. The action is practically instantaneous. The air in the cylinder exhausts through GFD and the plug valve C is then held to a tight seat, since the top area subjected to air pressure is greater than the effective bottom area by an amount equal to the area of the valve seat.

In the use of very heavy weights considerable shock results from dropping them suddenly through their free height when the exhaust is opened. This could be obviated by throttling the exhaust, but it is necessary that the weights become quickly effective. When an air passage is throttled, the flow of air as is well known becomes slower and slower as the driving pressure approaches that of the receiver (or, in this case, the atmosphere). It was therefore desired to lower these heavy weights quickly but without any shock due to their fall, until their free height was covered, and then to instantly release the supporting air thus allowing the weights to become quickly effective without the effects of kinetic energy due to their fall. In other words, a throttled exhaust was desired which however should open fully as soon as the weights had become but slightly effective, thus avoiding the delayed

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effectiveness during the latter part of an entirely throttled exhaust. To accomplish this, leakage is again made of service in two ways.

In this operation, the cap and nipple at D is replaced. The flow of air to the cylinder is exactly as before, and the air in port F supports valve K, but when the circuit is closed and plug C drops by its own weight, the exhaust cannot take place at D. There is however some leakage past the packing rings of the piston which operates the weights, and this leakage reduces the pressure in F. At the same time the top plug valve H is subjected to full air pressure in K since the magnet has closed valve N. As soon as the pressure in port F has been so reduced by cylinder leakage that its effect on the area of valve H is about equal to the effect of the pressure in K on the lesser area of the upper end of H, valve H drops, and air passes from the cylinder through G and out at the exhaust port marked EX. The areas of valve H and its upper or plug end are so proportioned that exhaust takes place when the reduction of the pressure in F is sufficient to allow the weights to drop gently through their free height. Regulation for different weights is readily effected by adjustment of a reducing valve which supplies the air to A.

Certain important proportions have been omitted until the last since their treatment involves an understanding of the more general operation of the valve. The leakage past plug C and through choke B must be so proportioned to the combined capacity of port E plus leakage past the upper or plug end of H, that when E is closed by the magnet, practically full pressure will accumulate on top of plug C, notwithstanding the leakage around plug H. On the other hand, this leakage around C and through B must be less than the leakage around H plus the capacity of port E in order that when valve N is open the pressure on top of plug C may escape and allow it to lift. This effect was easily secured by making both plugs a close fit to the reamed bores and grinding to a free but close working fit, adjusting the flow of air by means of choke B. The latter is shown for clearness with a drilled hole, whereas it is a solid plug with a tapered flat filed on its side, the plug being driven in until the desired effect was secured by trial.

It will at first appear that the action of the retarded exhaust is slow, whereas in reality it occupies but a fraction of a second, depending upon the pressure used. The diameter of the cylinder is five inches and the capacity of the valve is that of three-eighth inch pipe, a proportion that results in almost instantaneous action.

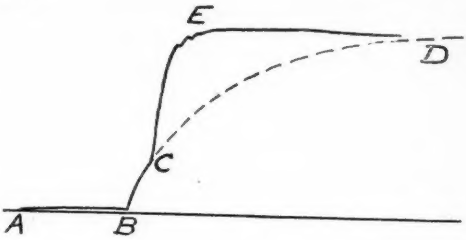


FIG. 2.

Pressure diagrams of the action of the weights (not of the air) exaggerated for clearness are shown in Fig. 2. The effectiveness of the weights is shown as ordinates on a time base. In the figure, when the valve N closes and the supply of air is interrupted, the weights are allowed to lower during the interval of time A-B, becoming slightly effective at B. Here, motion stops but cylinder leakage during a fraction of a second permits effective pressure of the weights to accumulate, and leakage alone would result in the pressure of the weights giving the dotted curve C-D. This slow action however is interrupted at C by the valve H opening and allowing the air pressure to escape, thus permitting the weights to act quickly but without the shock due to a drop through a distance. As stated, the figure is exaggerated. In reality the result is a gentle drop of the weights, without shock, the exhaust appearing to open the instant the weights are at rest, the actual pressure diagram being a steep and almost continuous curve. The valve has been in successful operation for some time and being made of brass is not subject to corrosion from moisture.

ENGINEER'S OPPORTUNITIES

Operating engineers often supply information to consulting engineers relative to their own plants and the latter puts the information obtained into neat typewritten form, and submits it to the employer of the operating engineer; then the latter wonders at the fees charged by the man to whom he gave the information. The prudent operating engineer

sends the desired information to his employer direct, thus eliminating the middleman, abolishing the fee system, and collecting what his services are worth. Every time an employer has to seek information relative to his power plant from parties not connected with its operation, the operating engineer overlooks an opportunity to increase his earning capacity. Why should any outsider know more about a given installation than the engineer who is living with it each day? Answer: They don't, if the operating engineer is as big as the job.—*National Engineer.*

AN EARTH MOVEMENT AIR BLAST

Last December, while engaged in the examination of a mine, near Wallace, in the Coeur d'Alene district, Idaho, it was my fortune to experience the shock of an "air blast" and to observe, thereafter its effect on the underground workings of the mine. I am writing the experience with the expectation that some readers of *Mines and Minerals* will be able to describe and explain the phenomenon.

The mine in question is opened by a tunnel and, from a point about one-half mile in from the mouth, a main working shaft 1,800 feet in depth has been sunk. The level on which I was at the time is at a depth of about 2,000 feet from the surface and I was more than 1,500 feet away from the shaft station.

About 3 o'clock in the afternoon, a time when we knew there was no blasting in the mine, we heard a dull, heavy boom, like a distant blast but not preceded by the usual "knock" of shots.

Our lights were blown and we felt the rush of air. Going to a point some distance out in the same drift we met the assistant engineer who was cutting down samples and he stated that he had felt the strong outward rush of air. To him the sound had appeared near, so that his first thought was to go in and see if anything had happened at the face of the drift where miners were working.

Half an hour later, one of the shift bosses came in and stated that the force of air had been strong enough to put out the candles of himself and another man who was with him, knocking the latter down. The apparent explosion, as we learned later, had occurred 200 feet above these men and 400 feet above the level on which my assistants and I were working.

Later we learned that a good many men working in places above and below the level on which the plainest evidence of the earth movement was visible, had experienced about the same shock.

A visit to the level, 400 feet above our working point, showed three broken posts and a pile of dirt 2 feet high along the drift for 2 sets. This dirt had come from the sides, not above, and the lagging overhead was not broken. It was apparently a settlement of a large rock mass, not a giving way of the timbering nor a distortion of the level.

When we left the mine, at the end of shift, I met State Mine Inspector Bell who, with Superintendent Davis, had been at the shaft station on the tunnel level, half a mile underground from the tunnel mouth. Neither of them (nor any one else at that point) had noticed any noise or air movement. However, on going to the mine office, about 300 yards from the tunnel mouth, I was asked by the bookkeeper as to what had hapened. He stated that he had felt the building shaking and rocking in a manner similar to a slight earthquake, but the movement lasted only a few seconds. He also had had a telephone message immediately from another mine office more than a mile away, where about as much of a shock had been felt, and where it was believed at first that it must be an earthquake.—*Mines and Minerals.*

PRODUCTION OF GASOLINE FROM NATURAL GAS

The following is merely the introductory position of a valuable but abstruse article in the September issue of *The Engineering Magazine,* by C. F. Hirschfield, Professor of Gas Power Engineering, Sibley College, Cornell University, and Consulting Engineer in Mining and Mechanical Engineering.

The constantly increasing demand for gasoline, and the difficulty experienced in meeting this demand with the product of the oil refineries lend great interest to any other possible method of producing this commodity. Such an alternative method has acquired considerable prominence during the past few years.

The process referred to results in the production of gasoline from what is called natural gas. By natural gas is meant any combustible gaseous material arising from wells in oil

and gas regions. Such gas ranges from "dry" gas, which consists largely of methane, CH_4, and has a specific gravity in the neighborhood of 0.6, to the very heavy vaporous "head casing gas" rising from oil wells. The latter gas often has specific gravity greater than unity as compared with air and contains appreciable quantities of the first seven or eight members of the paraffin series of hydro-carbons, i. e., methane, ethane, propane, butane, etc.

Little, if any, gasoline can be recovered from dry gas; comparatively large quantities can be obtained from the heavier varieties.

The plant required for the recovery of gasoline from gases of this kind is very simple and comparatively inexpensive. It will be shown later that several distinctly different methods might be used, each involving characteristic apparatus. At present, however, there is practically only one method and type of plant in use. This is shown diagrammatically in Figure 1.

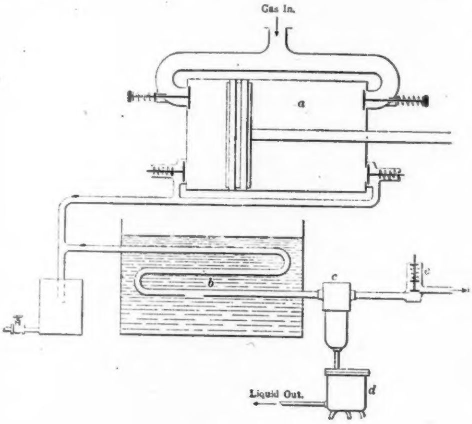


FIG. 1.

In this figure *a* is a compressor, *b* a cooler or condenser, *c* a separator, *d* a trap, and *e* a pressure-regulating or relief valve. In operation, gas is compressed in *a*, cooled at practically constant pressure as it passes through *b*, and the liquid gasoline which results is separated at *c*, from which it drains into the trap *d*. The trap discharges the gasoline into a convenient storage vessel or tank. The gas from which the gasoline has been removed passes through the relief valve to a distributing pipe system or to waste.

It will be observed that this apparatus is merely a simple modification of that used when natural gas is to be prepared for pipeline transmission. Indeed the process is merely an outgrowth of such preparation. It was often observed that a liquid drained out of natural-gas lines, particularly when the pressure was high and the temperature happened to be low. When investigation showed this liquid to be a high-grade gasoline, little further incentive was required to bring about the perfection and commercialization of the process just described.

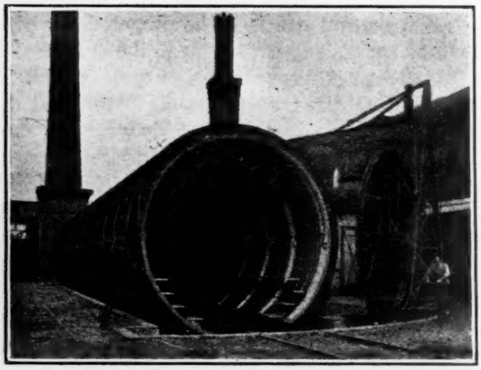
Experience has shown that as many as eight to nine gallons of high-grade cubic feet of heavy gas with specific gravity in the neighborhood of 1.1 referred to air. In general, the possible gasoline recovery decreases as the specific gravity of the gas decreases, becoming practically zero with a specific gravity in the neighborhood of 0.6.

The gasoline made in this way should properly be regarded as a by-product of the gas business and should be manufactured by each producer only to the extent made possible by the sale and utilization of gas. It is however almost unnecessary to state that this is not the actual condition of affairs; owners and operators of gas-producing properties have in many instances continued the manufacture of gasoline in such quantities that they have been compelled to waste large volumes of gas for which there happened to be no market. Such waste of our natural resources has been too well aired of late to require further comment.

NATURAL GAS FOR AN "AIR" LIFT

If you haven't the compressed air handy, and if you have lots of natural gas with a good pressure, and if you want water in a hurry the gas will do the work all right, although it might affect the potability of the water. A writer in the *Practical Engineer* tells as follows how the trick was actually done:

During the recent drouth, our cooling pond got very low and for make up water we pumped from a well near by, with natural gas. Not having an air compressor of sufficient capacity, and the company owning its own gas wells, we lowered 100 ft. of ¾-in. pipe into the well and connected it to the high-pressure gas line. The well being a drilled well 652 ft. deep, 6 in. in diameter and water within 20 ft. of the surface, we were able to get about 100 gal. a minute and kept up the supply until the drouth was broken.



FOR DISINFECTING RAILWAY CARS

The half-tone shows an installation of the Julius Pintsch company, at Hamburg, for the disinfection of cars of the Prussian State railways. The tank is an air tight wrought-iron cylinder, 16.4 ft. in diameter and 75.5 ft. long, firmly fixed on a foundation and provided with rails of standard gage so that it can take inside a railway coach of the ordinary European dimensions. It is provided, as shown, with a rolling door which can be hermetically closed against the open end.

The disinfection is carried on by the combined use of reduced pressure, elevated temperature and the application of a germicide in vapor form. The car is run into the tank and the door hermetically closed. The temperature of the interior is then raised to about 120° F. by means of steam pipes, which line the tank and at the same time pumps exhaust the air to about 27 in. of vacuum. At this temperature and pressure water boils and it is claimed that the combined action of the temperature and pressure causes the death of all vermin. To destroy all bacterial life, some germicide, such as formalin, is then introduced in vapor form from a small tank inside the main tank.

In operation it takes about five hours to effect complete disinfection of the car. One of these tanks has been in operation at Potsdam for some three years and is reported to have given complete satisfaction.

OXYGEN PRODUCTION IN SOUTH AFRICA

Examples of enterprise at the New Transvaal Chemical Co.'s works at Delmore multiply daily. The latest departure is in the direction of providing oxygen at a price and in sufficient quantity to encourage the use in South Africa of the oxygen-acetylene and various related welding processes involving oxygen. It is recognized that the heavy cost of importing oxygen cylinders has considerably handicapped these processes in this country. With this object the New Transvaal Chemical Co. has made arrangements with the British Oxygen Co., Ltd., the owners of the Linde patents, for erecting a large oxygen-making plant of the most modern type at Delmore. The plant will be capable of supplying, at a moderate figure, the whole needs of the Rand, and of South Africa even, in the event of the use of the new-welding process becoming as general as its many admitted merits warrant. The New Transvaal Chemical Co. will also supply the necessary plant and apparatus for the use of the oxygen process in workshops, etc.; and it is expected that this important addition to the Delmore works will be ready in a few months' time.

PROFIT IN REHEATING

The following data give the results of a test made in the shops of the Hansell Elcock Co., Chicago, in driving 1,608 ¾-in. rivets. Half of these rivets were driven using an ordinary air line, and half were driven using heated air from a Sterling Heater. This heater was described and illustrated in our issue of Nov., 1911.

A plain toggle portable yoke riveter was used. The compressor cylinder was 10 ins. in diameter and 9½ in. stroke.

An Excelsior Airometer was put in the line, at which point line pressures and line temperatures were read. Twenty feet of 1-in. rubber hose was used between the airometer and the Sterling heater. On the discharge side of the heater a gage and thermometer were inserted for reading the temperature and pressure of the heated air. Between the heater and the riveter 27½ ft. of 1-in. insulated flexible hose was used. The following shows the results:

	Without heater.	With heater.
Number of rivets	804	804
Ave. temp. of line air.	57.5 deg.	60.0 deg.
Average pressure, lbs..	85	85
Total cu. ft. air used..	14,874	8,513
Ave.temp. of heated air.	...	396 deg.
Cu. ft. air used per rivet	18.5	10.58

This difference in air used per rivet equals 7.92 cu. ft. or an increase in volume of 74.7 per cent. This increase equals an actual saving in air used of 42.7 per cent.

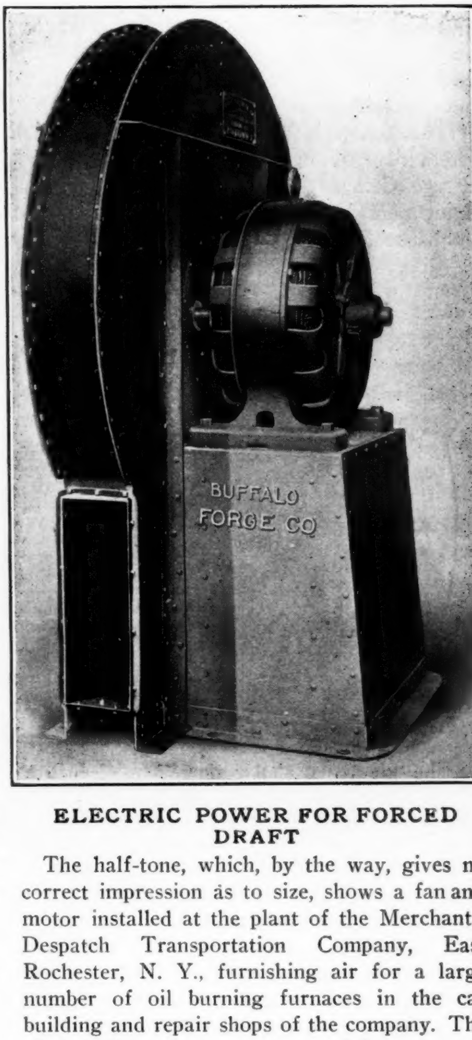
Assuming 1,500 rivets per day, the actual air saving equals 11,880 cu. ft. At 8 cts. per 1,000 cu. ft. this saving equals 95 cts., the cost of operating the heater equals 1 gal. oil at 10 cts. plus 8 cts. for ignition current equals 18 cts., total, a net saving of 77 cts. per day. This saving six days per week would pay for the heater in one year and leave a profit of $156.00.

The cubic feet of air given were actual airometer readings. On account of the intermittent service the heated air temperatures are not quite high enough. The actual temperature of the air supplied to the riveter was about 15 per cent. in excess to the heated air temperatures shown in the table.

The reheater is made by the Sterling Equipment Co., Peoples' Gas Building, Chicago, Ill., who are responsible for the figures here given.

USING AIR BRAKE PUMP EXHAUST

Heating trains with the exhaust steam of the air brake pump is made practicable, it is claimed, by a new device of which the essential feature is a special valve which relieves the back pressure on the air-pump cylinder at the point when the pressure of the air being compressed plus the back pressure is equal to the air pressure in the main reservoir. As long as the pressure of the compressor exhaust is higher than the steam pressure carried in the heating system, the valve will connect the compressor exhaust to the heating system; but as soon as the falling pressure of the compressor exhaust equalizes with the rising pressure in the heating-system reservoir, the special valves automatically operate to cut off the heating system and to open the compressor exhaust to the atmosphere. It is claimed that the operation of this valve is such that very little difference in the back pressure can be noted in the operation of the compressor with the valve and without it, and that 83½ per cent. of the total steam used to operate the compressor can be diverted by this method to the heating system. The valve spoken of is called "Econotherm," and is being put on the market by the Ward Equipment Company, 141 Cedar St., New York City.



ELECTRIC POWER FOR FORCED DRAFT

The half-tone, which, by the way, gives no correct impression as to size, shows a fan and motor installed at the plant of the Merchants' Despatch Transportation Company, East Rochester, N. Y., furnishing air for a large number of oil burning furnaces in the car building and repair shops of the company. The air is delivered at a pressure of 8 ounces per square inch, the oil having a pressure of 5 pounds due to gravity.

The blower is of the steel plate pressure type and has a capacity of 10,000 cubic feet of air per minute up to a pressure of 11 ounces.

The motor is of the constant speed induction type, with a capacity of 75 horse power, and is designed for operation on a three-phase, 60-cycle, 220-volt circuit, with a full load speed of 1,120 revolutions per minute. This rated capacity of the motor is greater than necessary to deliver the above volume of air so that the outfit is actually capable of delivering up to 14,000 cubic feet per minute.

The blower replaced a belted outfit which gave much trouble from the slippage and breakage of belts and which occupied much more room. It has been in operation several months and is giving excellent satisfaction.

The blower is known as No. 10 steel plate pressure type manufactured by the Buffalo Forge Company, and the motor is the well known CCL induction type made by the Westinghouse Electric & Manufacturing Company.

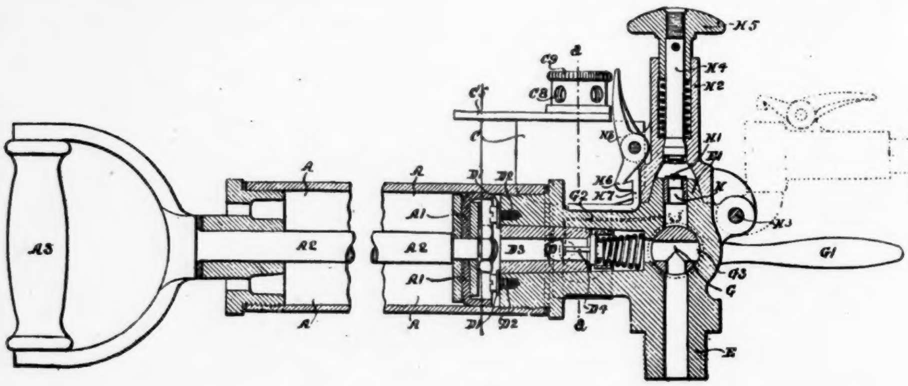


FIG. 1.

A STARTER FOR OIL AND GAS ENGINES

The cut above shows the essential features of an independent starting device for internal combustion engines which is the subject of a recent English patent. The appliance comprises a hand operated air pump the discharge of which is connected, through a passage way in which there may be either a spraying device for liquid or an inlet for gaseous fuel, to a chamber communicating with the engine cylinder isolable from the pump by a valve or cock, and in which there is a detonating device such as a fulminating cap and a hand operated striker therefor. Non-return valves are provided at the fuel inlet and between the pump and detonating chamber, and between the pump detonating chamber and cylinder connexion is a valve or valves such that the pump and the detonating chamber may alternatively be isolated from the cylinder—which latter valve may be so interconnected with the striker as to render the latter inoperative unless the valve is in the position permitting its operation and the discharge of the detonator without damage to the pump and its parts.

Upon operating the pump, air is drawn in through the aperatures C^8, fuel through the aperatures C^6, C^7. Their proportions and amounts are regulable by adjustment of the cap C^9 and handle C^5 respectively. In operation, the piston of the engine being at the commencement of a firing stroke, and the device being coupled to its cylinder by the arm E, the cock G is positioned to open communication between pump and cylinder, and the pump is operated until an adequate starting charge of mixture has been injected into the cylinder (to this end a pressure gauge may be applied to the cylinder arm E or axially to the cock G). The cock G is then moved to close connexion to the pump and open connexion between cylinder and detonating chamber, a cap having first been placed in position therein. The cap is then detonated by operation of the striking plunger H^4, so firing the charge and starting the engine.

Thorlakhavn, the best natural harbor on the south coast of Iceland, has been acquired by a French company, along with neighboring waterfalls yielding about 200,000 horse-power, and a plant will be erected at this place for manufacturing artificial saltpeter by the utilization of atmospheric nitrogen, according to the Birkeland-Eyde process.

In drilling for gas or oil in Fayette county Pa., recently, the Wharton Oil & Gas Company penetrated 29 feet of coal in sinking a well 530 feet in Wharton township. In drilling the well one three-foot, one five-foot, two six-foot, and one nine-foot veins of coal were drilled through.

METHODS AND COSTS OF APPLYING STUCCO WITH "CEMENT GUN"

BY R. C. HARDMAN*

The writer recently has had occasion to use the "cement gun" for placing stucco on the exterior of a small frame building, containing 631 sq. yd. of surface and having 56 door and window openings. He gives below the methods and cost of doing the work.

The building, which is two stories high, consisted of a main front with two rear wings, in the space between which the gun was stationed, with the sand and cement storages immediately behind. The typical force in the operation of the gun was one man running the engine and gun, two men mixing and sacking dry material and charging hopper, one nozzleman, one laborer to help nozzleman, and two laborers cleaning grounds and screeding.

The entire building was first covered with cheese-cloth, then with a cheap grade of building paper secured by laths running vertically on the studs. This was then covered with mesh reinforcement secured by 1½-in. staples. Grounds were placed on alternate studs to give a stucco thickness of 1¼ in. The panels thus formed were filled alternately to within about ¼ in. of the face of the grounds. The grounds were then cleaned off with a small trowel and about thirty minutes later the stucco was brought flush with their face and screeded off. The screeding was done by unskilled Mexican labor with a straight-edge shod with steel. When these panels were set, the grounds were removed and the panels between were filled in the same way. The work was done in four sections vertically. The top section was done first so that falling material might find a lodging place below. When a section was completed it was lightly sprayed to secure uniform color and cover up joints. The mixture used throughout was one part of portland cement to three parts of sand.

In shooting the mixture onto the wall the nozzleman stood so that the nozzle was from three to four feet from the wall, and kept the nozzle in continual motion so as not to pile up too much mortar in one place. In accordance with the principle of the device, the dry mixture was mixed with water at the nozzle. The amount of water used was just enough to keep the mortar below the running point. Water was delivered at about 40 lb. pressure. The air pressure used was 26 lb. A higher pressure than this caused too much waste of material (mostly sand) by rebounding, and a lower pressure tended to clog the hose with dry material.

The apparatus consisted essentially of an engine, an air compressor and the "cement gun," which is a hopper, having a caisson lock, for receiving the dry material and from which it is forced through a hose to the surface to be covered. As used the outfit comprised a 4-cycle, 4-cylinder gasoline engine, connected to a 2-cylinder single-acting air compressor by means of belt and pulley operated by a belt tightener. On the front of the engine and operated by its flywheel was a small water pump for the engine water-cooling system. A second water pump attached to the compressor and operated by its flywheel was available for pumping water to the hose nozzle. Neither of these pumps was used, as the water pressure from the mains was sufficient.

Connected to the air compressor was the hopper or "cement gun" proper. This consisted of two connected air chambers—upper and lower—each closed at its top by a flap valve hinged to swing downward by gravity and closed by outside levers. The feeding mechanism, which consisted of a revolving slotted wheel, was at the bottom of the lower chamber and allowed the dry mixture to fall through and be forced through a hose, at the nozzle of which it was mixed with the proper amount of water.

In operation the lower chamber was first closed by its valve and filled with air. The dry mixture, which previously had been sacked for convenience, was put into the upper chamber, the upper valve closed and the air turned in. As soon as the pressure in the upper chamber equaled that in the lower the valve connecting the two chambers opened by gravity, allowing the dry mixture to fall into the lower chamber where the revolving slotted wheel allowed it to feed through into the hose connected to the bottom of the lower chamber under the feed wheel. When sufficient material had been forced from the lower chamber to allow its valve to be closed, the exhaust from the upper chamber was opened and the pressure reduced until the lower valve was held closed by the pressure in the lower chamber.

*Civil Engineer and Superintendent of Construction, U. S. War Dept., Fort Huachuca, Ariz.

The upper chamber was then again filled with the dry mixture, so that the feeding and discharge through the hose was continuous and uniform.

The feeding mechanism was operated by a paper wheel and friction disk controlled by a lever. The dry mixture passed through the feed wheel into the hose and was then picked up by the air directly from the compressor and forced through the hose. The hose used was a 2-in. steam hose.

TABLE SHOWING COST OF STUCCOING 631 SQ. YD OF SURFACE WITH CEMENT GUN

		Cost	Cost per Sq.Yd.
Material for Lathing:			
Cheese cloth 631 sq.yd. at	$0.035	$22.9	
Building paper 56.8 squares at	0.30	17.04	
Wire, 631 sq. yd. at	0.1278	80.64	
Lath, 500 sq.yd. at	5.25M	2.63	
Nails, 10 lb. at	0.04	0.40	
Staples, 200 lb. at	0.0425	8.50	
		$131.30	$0.2081
Labor for Lathing:			
Carpenters... 16 hrs. at	$0.5625	$ 9.00	
Carpenters... 59 " "	0.50	29.50	
Carpenter helpers.......144 " "	0.375	54 00	
Laborers.... 33 " "	0.218	7.22	
Laborers:Mex;41.5" "	0.156	6.49	
		$106.21	$0.1683
Total for Lathing..		$237 51	$0.3764
Material for Plastering:			
Portland Cement 65 bbl. at	$3.43	$222.95	
Sand (at site)..........			
		$222.95	$0.3533
Labor for plastering:			
Nozzleman.... 96 hrs. at	$0.5625	$54.00	
Engineer.....100 " "	0.375	37.50	
Laborers, mixing.......212 " "	0.156	33.13	
Laborers on wall.......156 " "	0.166	26.00	
Laborer (hose).59 " "	0.218	12.94	
		$163.57	$0.2592
Fuel:			
Gasoline, 97.5 gal. at	$0.22	$21.45	
Lubricants.............		4.90	
		$ 26.35	$0.0418
Total for plastering..........		$412.87	$0.6543
Total....................		$650.38	$1.0307

Time: 12 days.
AVERAGE: 52.51 sq. yd. per day

The resulting cost per square yard appears rather high, but it must be remembered that the stucco is 1¼ in. thick (the average thickness is somewhat more owing to the stretching of the cloth between studding), the cement is high in cost, and efficient labor difficult to secure. The nozzleman was an experienced man, but all other labor was unfamiliar with the work.—*Engineering News.*

MINE GASES

White damp is the gas most feared by the miners, for its properties render it difficult to detect, inasmuch as it is tasteless, odorless, and colorless, and when mixed in the proportion of about one part of gas to nine parts air is called "fire damp," and becomes explosive to a degree hard to realise unless one has seen its effects. Black damp, unlike white damp, is heavier than air, and is a non-explosive gas which may be detected by its peculiar odor. Again, unlike the other, its effect is to suffocate and extinguish fire. This gas is so heavy and moves with such a sluggish flow, that occasionally when miners have been trapped in a mine following an explosion, and have detected the black damp creeping in on them by its smell, they have been able to stop its advance by erecting dams or barricades along the floor, building them higher as the volume of gas increased, and keeping the air within their little enclosure comparatively clean by rude, improvised fans. Following an explosion, these two gases become mingled, and form a mixed gas possessing all the dread qualities of each, which is known as "after damp," and it is this mixture of gases which destroys any life that may remain following a mine disaster.

AN AIR CUSHION AUTO

The air cushion automobile invented by Josef Hofmann, the pianist, and constructed at the Saurer Machine Works in the consular district of St. Gall, Switzerland, promises to bring about a revolution in automobile construction. In place of the usual steel springs it has four brass cylinders for compressed air resting on the axles under the four corners of the automobile body, and these, by means of pistons and soft leather diaphragms, greatly reduce the swaying and jolting.

It is claimed for the new invention that it is adaptable to all kinds of roads, regardless of speed or weight of machine; that the air cushions work instantaneously with softness and ease of movement; that there is an entire absence of vibration, as no metal springs intervene between the axle and the car body; that there is almost perfect balance in rounding curves; and that there is as nearly perfect working safety as can be secured. The machine has been undergoing severe tests for several months, having already run more than 4,300 miles over unfavorable roads.

COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC

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CONTENTS

COMPRESSED AIR TRANSFORMS THE TRADES

It is not easy to realize how completely some of the more prominent and important of the mechanical trades have been transformed by the general adoption of compressed air operated apparatus. We are thinking here of the workman in the shop, of the change in the demands upon his individual strength and skill and of the difference in both the quality and the quantity of his output which has followed the incoming of the modern methods and facilities, especially the pneumatic devices.

Tools and apparatus operated by compressed air have not only relieved the workman from the exhausting physical exertion which was required all through the trades, and which brought premature old age if the occupation was constantly followed, but have actually superseded and surpassed the slowly developed skill of manipulation of the workman of the olden time. It is idle to regret the decadence and the disappearance of the skill which there is no longer any use for. The earning power of the workman has not been reduced in consequence. He gets as much on the average as he ever did, and he gets it easier and in fewer hours, and where he does not it is not compressed air or electricity or any other of our latter day alleviators of toil which are to be blamed for it.

It is quite commonly thought that the trade of the boilermaker has been more completely transformed than any other, since once its operations were almost exclusively manual and depended upon highly developed skill in the workman, while now there is little or nothing in the boiler shop which is not done, and better and more quickly done, by air operated tools, but in fact the transformation of the molder's trade has been almost as complete, while foundries and their operatives are much more numerous.

Mr. W. H. Armstrong in a recent address before the New England Foundrymen's Association at Boston, which is altogether too long for reproduction in our pages, mentioned in succession, with brief remarks upon the function of each, the various types of air operated devices which now are employed in every up-to-date foundry, and without which it is not too much to say that no foundry can be successfully operated.

A foundry needs an air compressor almost as much as it needs a cupola, and proper thought should be given to its selection and installation and operation so that the air in volume and pressure may be always ready wherever it is needed throughout the plant.

The most extensively distributed line of apparatus, but by no means entailing the greatest consumption of air, will be the air hoists. The single cylinder direct vertical hoist is one of the simplest of devices and perhaps the most serviceable of all, while the geared motor hoist has also its special line of applicability, and the motor applied to the geared crane does the heavy work. These hoists are all used intermittently, and there is no charge against them for air except for the little time when it is actually in use. Hoisting is an operation constantly occuring in the foundry and in the molding work air doubly supersedes hand lifting in that when a thing is hoisted, as for instance a cope which has been rammed, it is not necessary to set it down anywhere, but it can be held suspended and turned over for examination or for retouching and finishing in the most convenient position, and when all is ready the mold can be closed as gently and safely as could possibly be required.

Ramming sand was the molders hard work all day, and the carrying of the heavy ladles closed his labors, but now he is relieved of both; of the latter, by the hoisting and conveying devices, and of the former by the various types of sand rammers, little and big, and the molding machines, first the squeezers and now the jolting machines, one or the other, as best adapted for the special job, packing the sand with just the required firmness and with the repetitive precision which human hands could never equal.

Then there are the chipping hammers and the various sand blast arrangements for cleaning the casting, and other minor employments for the air, all lightening the molders' task and greatly increasing his effiiciency thereby.

Much more might have been made of the Rip Van Winkle legend than Irving ever dreamed of. He should have been a mechanic and he should have lived a century later. The time is ripe for another Rip to wake up, and he might as well be a molder.

A TUNNEL ENGINEER DIES

The hazards of engineering are not spectacular and the risks the engineer must run are not of a kind which thrill the reader. Yet they demand their toll of life like all other risks, and while that toll is generally levied on the young men of the engineering rank and file it must sometimes be paid by eminent men like Charles L. Harrison, who passed away on Sept. 15 as a result of devotion to his duty as assistant chief engineer of the East River division of the Pennsylvania terminal improvements in New York. It is only recently that his marked ability as an engineer came to be recognized by the profession generally, for he said very little and wrote less about his own work. But he nevertheless had a large circle of influential friends, with whom he spent his leisure hours, and his standing among them was shown by unusual proofs of reliance in his integrity which need not be narrated here. When the construction of the East River tunnels was begun he realized that the compressed air work would present some danger to a man of his physique, but he accepted the risk, and when, just at the end of the work, he fell a victim to too rapid decompression, no complaint escaped him. For four years he lived a very quiet life, and his many friends lately rejoiced at an apparent improvement in his health. But it was only apparent, for his weakened heart was unable to carry him through the strain of a hard cold. There are many engineers who will think of the loss the engineering profession has sustained whenever they use the tunnel between Manhattan and Long Island City, and his influence will be felt for many years through the effect of his fine example on the young men under him.—*Engineering Record.*

COMPRESSED AIR CHURNING

In our list of patents for July 30, we unfortunately omitted No. 1,034,350, to Alpheus Fay, Louisville, Ky., covering an improved churning process. It provides for the production of violent ebullition in a volume of milk by the "tangential collision" of two jets of air, the containing vessel having unobstructed concave walls. The ebullition is produced for a period of from 30 to 60 seconds. If the churning process is made as short as that it will be a revolution indeed,

and may lead to important changes in dairy practice; and of course every dairy will want a compressor.

UNDERGROUND TEMPERATURES AND WORKING CONDITIONS

The New Zealand Mine Commissioners say in the course of a recent report that in deep metal mining it is sometimes necessary to circulate a larger volume of air than is required to produce, from a quality standpoint alone, adequate ventilation. For the purpose of reducing the temperature of the rock-surfaces a greater volume of air is necessary, for if this were not effected hard work would be either intermittent or unbearable in the heated atmosphere of many deep and hot mines. Observations made with the object of determining the rate of increment of temperature with depth in several countries where deep mining is conducted have shown considerable divergence in different places, as will be seen from the following comparisons of the results of temperature observations:

Locality.	Depth required for an increase of 1° F. Feet.
Comstock, U. S. A.	33
Witwatersrand, Transvaal	208
British Colliers(mean)	64
Bendigo, Victoria	77
Ballarat, Victoria	80
Thames, New Zealand	43.5
Waihi, New Zealand (approximate.)	32.8

The relative rock-temperatures at the 1,000 feet level at Thames and at Comstock are 83 degrees Fahr., and at Waihi approximately 85 degrees Fahr., but it was fond that, owing to various causes, the temperature throughout the Waihi Goldfield at any particular horizon was by no means constant. During the investigations the Commissioners found that the air in the working-places at Waihi and Thames was highly saturated, generally to the extent of 90 per cent. or more, and that the wet-bulb temperature of the air in working-places ranged between the following limits at the deepest levels:

	Underground. (Wet Bulb).	Outside in Shade (Dry Bulb).
Thames Goldfield (1,000 ft. level)	70.0° to 83.5°	55.0°
Waihi Mine (1,000 ft. level)	61.0° to 82.5°	56.5°
Waihi Grand Junction Mine (944 ft. level)	64.5° to 83.0°	55.0°
Waihi Extended Mine (960 ft. level)	79.5° to 89.0°	50.0°

On the Reefton Goldfield the rock-temperatures are not nearly so great, the highest temperature recorded,—viz., 78° Fahr., wet bulb—being obtained at the 1,266 ft. level in the Progress Mine. To reduce excessive temperature and to cause an appreciable current to circulate through the heated stopes of the mines, an increased volume of air is necessary, but the extent to which underground temperature may be reduced by this means is somewhat limited, as our investigations have proved. The rate of increase in temperature of the outside air when conveyed into deep mines is demonstrated by the following measurements taken by us. During our inspection of the Thames mines we ascertained by actual measurement that atmospheric air which entered a Root blower at the surface, and was forced at a velocity of 10 feet per second through a thin galvanised-iron 22 in. air-pipe down a vertical shaft 1,000 feet in depth, and along a crosscut 670 feet in length, increased in temperature in the space of 2 minutes 47 seconds from 55° to 76° Fahr., being at the rate of 7.64° Fahr. increase per minute. The temperature of the air surrounding the pipe did not exceed 81° Fahr. At the Waihi-Grand Junction Mine we found that the temperature of the air, while passing from the top to the bottom of a vertical downcast shaft 955 feet in depth, increased at the time of measurements from 51° to 56° Fahr., the velocity of the air being at the rate of 16 feet per second. In this case the temperature of the air in the shaft increased at the rate of 5° Fahr. per minute. The return air in the fan passage at the surface of this mine was 69° Fahr. (completely saturated). From the foregoing examples it will be noted that in the North Island of New Zealand, where the outside temperature is equable (the mean surface temperature at Waihi being 55.7° Fahr.), the temperature of the air descending into the mine will have attained that of the rock-surfaces within seven minutes of entering the shaft. In discussing the effect of high temperatures on miners, the British Royal Commission on Mines (1909) reported as follows: "The influence of high temperatures on men is intimately de-

pendent on the moisture in the air, and also on its motion, for the greater the dryness of the air and the greater its motion the more rapidly does warm air carry off the heat of the body and thus neutralise the ill-effect of the heat. The existing evidence indicates that in still and saturated air continuous hard work is practically impossible at temperatures exceeding about 80° Fahr., even when men are stripped to the waist, and that when the air-temperature is higher than this the result is the same if the wet bulb temperature rises about 80° Fahr. A temperature of 100° or 110° Fahr., with the air so dry that the wet-bulb temperature is only 80°, is thus no worse than air completely saturated with moisture at 80° Fahr. In other words, it is the wet-bulb temperature, and not the actual temperature of the air, that matters to a man when the air-temperature is high. In moving air, however, a somewhat higher wet-bulb temperature can be borne than in still air. At wet-bulb temperatures exceeding about 80° Fahr., the amount of continuous work which a man is capable of doing without serious rise of bodily temperature rapidly falls off and becomes practically nothing at 90° wet bulb."

The report adds:—"As a result of our investigations and deductions from the foregoing evidence, we are of opinion that, to secure a continuous distribution of the air in metal-mines adequate to reduce the temperature in hot working-places within reasonable limits, a standard or fixed temperature of 80° Fahr., wet bulb, should not be exceeded, unless it is not reasonably practicable to maintain the air at such standard, in which case a reduction of the hours of employment should be provided for.

AN OIL AND COMPRESSED OXYGEN EXPLOSION

A severe explosion in connection with the starting up of a Diesel engine occurred recently at Bray, Ireland, and it carries a lesson which should be heeded. The circumstances of the accident are presented clearly in the report of the matter by Mr. D. E. McDonnell, the assistant electrical engineer, who wrote as follows:—

"On Sunday, the 7th inst. (July), the starting air of the Diesel was lost, and, following the instructions of the engine builders, Mr. Sowter sent to Dublin for a 40 ft. cylinder of oxygen. On the 10th we charged the blast receiver from this cylinder, raising the pressure from 350 lb. to 700 lb., and also passed a little into one of the starting receivers; the pressure in the latter was about 350 lb.

"I started up the engine in the usual manner, and, going on to platform, put the starting lever into the running position. The engine did not appear to be running properly, but before I could discover what was wrong the fuel valve on the cylinder cover of the engine exploded; the flame from this burst along the blast pipe, reaching the blast receiver, which then also exploded.

"I attach copy of the paragraph from the makers instruction-book which relates to the use of oxygen. From this you will see that we had every reason to believe that there was nothing hazardous nor very unusual in using this gas:—'If by any mishap the air is lost, and no compressor is available, or if the engine cannot be run by external means so as to charge the receivers with its own compressor, then these may be charged with carbonic acid gas or oxygen from cylinders containing these compressed gases, as used for many purposes.'

"In the ordinary course of events there would be no explosive mixture in these receivers, and I consider that there is no danger of a repetition of such an explosion. Personally, I will have quite as much confidence in the Diesel engine as I had before the accident."

The *Electrical Review* has, by inquiries, elicited the fact that the connection from the blast receiver to the fuel valve of the engine consists of about 14 ft. of 3-8 in. bare copper tube. Crude Texas oil fuel has been used since the engine was installed, about 2½ years ago. No other quality has been used except to start the engine, should she have been lying off for any time, or have been dismantled when ordinary paraffin oil (kerosene) is used.

More than one authority has investigated and reported upon the accident, the chief engineer of the National Boiler and General Insurance Co., stating that the accident was not in any way due to defective design or construction of the engine or of the air receivers, but was owing solely to the use of oxygen for raising the pressure in the latter.

The Bray Council engaged Dr. Lilly, of Trinity College, and Mr. William Ross, M. I. M. E., of the firm of Ross and Walpole, En-

gineers, Dublin, to report on the accident, and the following are pertinent extracts from their report:—

"We find that the explosion in the Diesel engine was due to the use of pure oxygen instead of air. The builders of the engine were cognizant of the fact that oxygen was being used for starting the engine, as stated in your engineer's letter to them of February 15th, 1912. It appears that the use of oxygen for such a purpose in engines of this kind is dangerous. This explosion resulted from its use.

"The condition of the engine and wreckage points to the conclusion that the explosion was caused by the presence of the oxygen with fuel, somewhat in the following manner:—

"Near the completion of the compression stroke of the engine, the compressed air being charged with oxygen and fuel, exploded in the engine cylinder, with a rise of pressure far above that obtained under the usual working conditions with air. This pressure exceeded that in the air injection cylinder and pipe connected to the fuel valve; the flame from the engine cylinder ignited the mixture, and caused the explosion to be transmitted through the connecting pipe to the air-infection cylinder.

"The condition of the wreckage of the air-injection cylinder indicated that the explosion was instantaneous, and gave rise to enormous pressure. This was probably due to a rich mixture of nearly pure oxygen and oil vapour in the cylinder."

That reputable builders could ever have put themselves upon record as recommending or even permitting the use of oxygen in this way would seem to be one of these cases where truth is stranger than fiction. The occurrence points the way to the more universal installation of air compressors with small gas or oil engines to drive them.

NOTES

A recent German patent covers an arrangement for the preservation of oil paintings by the use of nitrogen. An air tight case with a glass front encloses the entire painting and the space is filled with nitrogen.

A bill has been presented in the House of Representatives which provides for the establishment of a Bureau of Farm Power, in the Department of Agriculture. The province of the bureau would be to investigate and report on all matters pertaining to methods of furnishing power on farms, and all labor-saving machines in agriculture.

The following was found on the bulletin board where machine runners mark up their troubles, at a certain coal mine: "No. 4 Masheen awl Shot tu hel. Chain brok. fix the dam thing. it brok twist Last nite. needs new rearstaff leaver for the resisting box. amatoor smokes like heltoo. Power bad. lots of short circles. this is the masheen with self compeller truck. Wer outa oil tu."

At a recent agricultural show in France acetylene lamps were exhibited designed for attracting and destroying moths of harmful species, and more especially cochylis, one of the vine's especial enemies. A less laudable use of acetylene lighting has been the employment of acetylene lanterns by certain "sportsmen" with the object of attracting game, and it has now been decided in France that such aids to increasing the "bag" are illegal.

In the report of the medical inspectors of factories in Illinois one plant is cited which had 73 cases of lead poisoning last August, due to dry sand-papering of lead paint. With the use of a simple respirator for the protection of these workers as recommended by the department, the hazard of this occupation has been so far reduced that there has not been a single case of lead poisoning in that particular establishment in the last four months.

An English paper makes the statement that forty firms are building turbines in England, 20 building marine turbines exclusively. Of the marine turbines built, all but two are of the reaction type; but of the land turbines about 14 are impulse machines of various designs. At least two firms are specializing in small turbines. On the Continent there also appear to be 40 firms known to build turbines. About eight are reaction turbines and the remainder impulse.

An explosion and fire at the plant of the Sun Oil Co., Toledo, Ohio, caused the death of one employee and the injury of three others. According to reports the accident was due to escaping gas, from a tank-car of gaso-

line, coming in contact with a fire in the boiler room, 75 ft. away. After the explosion, the flames jumped back to the car of gasoline and to a still containing gas, and the latter also exploded, scattering debris around the plant and adjacent property.

A machine combining two modern inventions, the electric car and the vacuum cleaning apparatus, has been applied in Strassburg to clean the tramway tracks of that city. In the operation of the machine the roadbed is sprayed with water, then the dirt is loosened by a scratcher and drawn up into the car by the suction apparatus. With this machine one man can clean 25 miles of track a day, replacing the labor of 17 men working in the ordinary way.

The Bureau of Gas and Electricity of New York City reports to the Public Service Commission that during August it tested 28,509 gas meters, of which 3,773 were new meters, 24,603 were repaired and removed meters, and 133 were tested on complaint. The law allows a deviation by gas meters of 2 per cent. in either direction from absolute accuracy, and of the meters tested on complaint 53.5 per cent. came within this limit, 12.6 per cent. were more than 2 per cent. slow and 33.9 per cent. were more than 2 per cent. fast.

A good deal has been recently heard about "holes in the air" in connection with sudden collapses of flying machines. Prof. W. J. Humphreys, of the Washington Weather Bureau, writing in the *Popular Science Monthly* classifies the eight different types of atmospheric disturbance as follows:—A vertical group, including aerial fountains, aerial cataracts, aerial cascades, and aerial breakers, and a horizantal group, including wind layers, wind billows, and aerial torrents; in addition, wind eddies fall under both groups. Holes in the sense of vacuous regions do not exist.

Preheating air for internal combustion engines was recently discussed in Le Génie Civil by A. Nougier. The author recommended passing the air over tubes in a preheater taking much the same form as a tubular boiler, the exhaust products from the engine cylinder passing in the reverse direction through the tubes. He claimed that it is possible to construct a heater capable of preheating the air to 175 deg. Fah. at no load without overheating the air at full load. Such a heater for a 200 horse-power motor would be 23 inches in diameter and contain 100 tubes about 40 inches long.

Ventilation by individual air ducts has been tried at one of the public schools in Minneapolis under the direction of the engineering division of the Minnesota State Board of Health. The air was discharged through individual funnel ventilators placed beside each desk. It was found in experiments extending over a period of four weeks that satisfactory ventilation could be maintained in this way by supplying only 8 cu. ft. of air per minute per pupil as compared with 30 cu. ft. required under the ordinary fan system of ventilation.

Fifty-eight miles an hour, attained by the hydroplane "Tech, Jr.," in speed trials on Huntington Bay, Sept. 5, makes a new record for fast speed on the water. The boat is 20 ft. long and has a beam of 7 ft., and her hull below the water line is flat. She was built by Adolph Apel, at Vintnor, N. J., and is driven by an eight-cylinder Sterling engine of 150 hp. When traveling at high speed, the boat is out of the water, from a half to two-thirds of her length, a large part of the time.

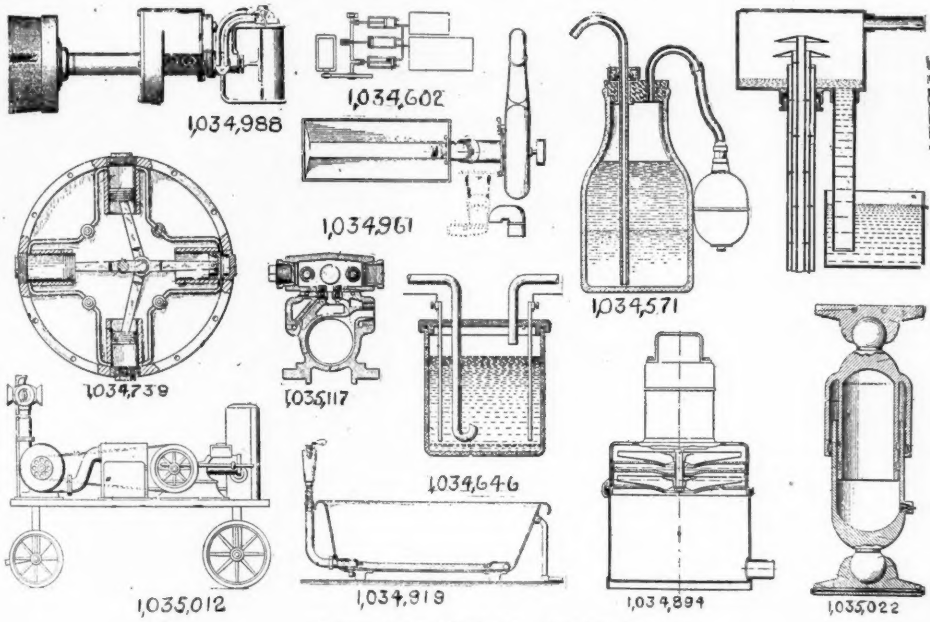
The Engineer, London, describes as a German invention and the subject of a recent German patent what we in the United States are already quite familiar with as the Cement Gun. A detail of the German patent spoken of covers the use of compressed carbonic acid gas instead of air to hasten the setting of the mortar. This might work, but would be far too costly on account of the quantity of gas required.

There has just been put out of service at the Dolcoath Mine an engine which was erected in the year 1815. During all the intervening period it has been working faithfully and well and is a tribute alike to Cornish mechanical genius and workmanship. That it has now ceased to perform its functions is due to no sense of lack of duty or weariness in well-doing, but simply to the circumstance that the old at Dolcoath is giving place to the new. So it comes to pass that this fine old piece of

mechanism, when still capable of service, is put out of commission. We do not know if it is the habit of Dolcoath to "pension off" its discarded machinery, but if ever "5s. a week" were deserved surely it is by this old engine which has served the mine since the year when Wellington won the battle of Waterloo.—*Mining World,* London.

There is a somewhat remarkable man in the employment of Messrs. Holman Bros., Ltd., the widely celebrated firm of engineers at Camborne. His name is Henry Veal, and he is 86 years of age, having been born in the year 1826. He was working in the pneumatic air cushion shop on Tuesday week with as much diligence as any of his younger confrères. For 43 years he has been thus employed, and according to all appearances is likely to complete his half century, or more. He has always refused to take any holiday.—*Mining World,* London.

The new railway that will pass through the Loetschberg tunnel, in the Bernese Alps, is protected from avalanches by great fortifications. At the southern entrance to the nine-mile-long tunnel a massive stone wall has been built, 30 feet high, and seven or eight feet thick at the base. Behind and above this wall is a kind of trough. When a descending avalanche strikes this depresssion it will be diverted upward, and clearing the railway below in a parabolic curve will descend into the Lonza torrent beyond. The snow swept down by avalanches in this region somtimes attains a depth of 80 feet. In February, 1908, a building of the railway works was struck by the rush of air set up by a snowslide, and was swept bodily into the river below. There were 11 men in the building, and all of them lost their lives.



PNEUMATIC PATENTS, AUGUST 6.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

AUGUST 6.

1,034,571. LIQUID-SEPARATOR. EGBERT A. BIDWELL, Jefferson City, Mo.

1,034,602. COMPOUND AIR-COMPRESSOR. ALEXANDER ENGLAND, Wilkinsburg, Pa.

3. In a compound compressor having high and low-pressure cylinders and pistons, a shaft for driving said pistons and connections between the pistons and shaft so spaced as to produce a continuous net resistance on said shaft throughout a complete revolution.

1,034,646. PROCESS OF PURIFYING HYDROGEN. GUSTAV H. RABENALT, Dover, N. J.

1,034,703. APPARATUS FOR RAISING WATER. NAT H. FREEMAN, Denver, Colo.

1. The combination with a water supply source, of a standpipe whose lower extremity is in communication with said source, a plurality of pipes arranged one within the other within the standpipe, the outermost pipe being suitably spaced from the inner surface of the standpipe, and the various pipe members within the standpipe being suitably spaced from each other, whereby the space through which the water is to be raised is suitably subdivided, the lower extremities of the compartments formed by the said pipes being open and in communication with the water supply, and means for introducing air under pressure into the standpipe outside of the outermost pipe member, the pipe members constituting the compartments through which the water is to be raised being equipped with air jet nozzles, whose outer extremities are in communication with the air under pressure within the standpipe, a reservoir with which the upper extremities of the compartments are in communication, and means for exhausting the air of the said reservoir above the water, substantially as described.

1,034,739-40. FLUID-CLUTCH. ALVIN H. SHOEMAKER, Portland, Oreg.

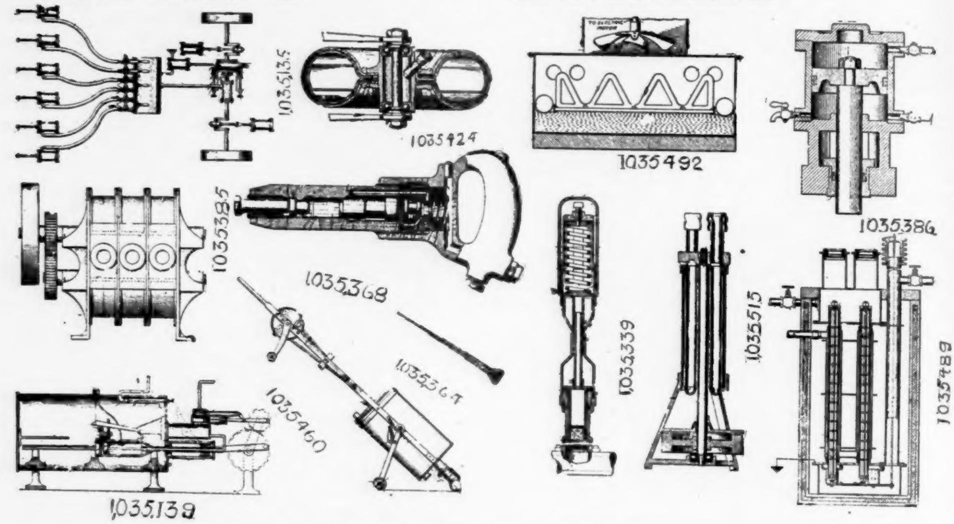
the drive shaft and having a friction disk bolted upon one face and concentric with the shaft, a pulley having a peripheral groove secured upon the other face of the eccentric and concentrically with respect to the shaft; a collar seated in said groove and extending beyond the same, and means connected with the collar and operable by air pressure to move the friction disks out of engagement with each other.

1,035,139. AIR-COMPRESSOR. CHARLES P. AUGUSTINE, Hamilton, Mont.

1,035,281. AIR-DRYING APPARATUS FOR METALLURGICAL PURPOSES. BRUCE WALTER, Pittsburgh, Pa.

1. In air drying apparatus for metallurgical purposes, a tower having superimposed compartments, a partition separating the compartments and arranged to allow upward flow of air therethrough while preventing downward flow of liquid, means for passing air upwardly through said compartments in succession, and means for subjecting the air to the action of separate refrigerated liquids in the said air compartments; substantially as described.

1,035,337. AIR-TESTING APPARATUS. WALTER H. FLOOD, Chicago, Ill.



PNEUMATIC PATENTS, AUGUST 13.

1,034,863. PNEUMATIC STAMPING PLANT. HANS CHARLES BEHR, Johannesburg, Transvaal.

1,034,894. AIR-PUMP. PEDER ANDERSEN FISKER, Copenhagen, Denmark.

1,034,919. PRODUCTION OF AERATED BATHS. ANDREAS WALTHER LEUSCHNER, Dresden-Alt, Germany.

1,034,961. PNEUMATIC CONVEYER. EDWARD F. BIRKENKAMP and THEODORE F. BIRKENKAMP, Farmersville, Ill.

1,034,988. PNEUMATIC-POWER PAINTING-MACHINE. FRANCIS DYKES, Elizabeth, N. J., and DAVID E. WELLS, New York, N. Y.

1,035,012. INSECT-DESTROYER. CHARLES VAN PELT HOSELTON, Carterville, Mo.

1,035,022. CUSHIONING DEVICE FOR USE ON CARS. LAURENCE L. LEASURE, Winfield, Kans.

1,035,117. LUBRICATOR. GEORGE H. GILMAN, Claremont, N. H.

AUGUST 13.

1,035,135. CLUTCH MECHANISM. JOHN M. ANDERSON, Fullerton, N. D.

1. In a machine of the class described, the combination with a drive shaft having a friction disk keyed thereto, an eccentric loosely fitted on

1,035,339. LIQUID CUSHIONING DEVICE. THOMAS J. FOX, Memphis, Tenn.

1. In apparatus of the class described, the combination with a pipe, of a cylinder in communication with the interior of the pipe, a plunger working in the cylinder, a spring resisting movement of the plunger away from the pipe and means whereby substantially the entire pressure of liquid in the pipe may be transmitted to the plunger through a cushioning body of confined air.

1,035,341. PNEUMATIC CLEANER. CHARLES BURDETTE GILMORE, Bloomington, Ill.

1,035,358. PNEUMATIC HAMMER. HARRY KELLER, Philadelphia, Pa.

1,035,364. ELASTIC-FLUID COMPRESSOR. MAURICE LEBLANC, Croissy, France.

1. In a rotary elastic fluid compressor, blades composed of vegetable fibers stretched parallel to each other radially to the rotor and united together by a suitable agglutinant, substantially as described.

1,035,372. VACUUM-SWEEPER. FRANK J. MATCHETTE, Milwaukee, Wis.

1,035,385. BLOWER OR PUMP. ALBERT W. PEARSALL, Lowell, Mass.

1,035,386. AIR-CUSHION FOR PUMPS. FREDERICK M. PRESCOTT and EUCLID P. WORDEN,

Milwaukee, Wis.

1,035,424. PNEUMATIC WHEEL. CHARLES DE LOS RICE, Hartford, Conn.

1,035,460. VACUUM CARPET - CLEANER. DAVID A. MINNICH, York Pa.

1,035,489. APPARATUS FOR THE PRODUCTION OF OZONE. JAN STEYNIS, Bay Shore, N. Y.

1,035,492. HUMIDIFIER. CHARLES SUBERT, Chicago, Ill.

1,035,515. HYDRAULIC VACUUM - PRODUCER AND AIR-COMPRESSOR. MARTIN ARMSTRONG, Kansas City, Mo.

1,035,603. AIR-WASHER. MORRIS S. KING, New York, N. Y.

1,035,684. METHOD OF PRODUCING COMPOUNDS OF OXYGEN AND NITROGEN. PAUL BUNET, Paris, and ADRIEN BADIN, Salindres, France.

1. A process for electrically producing compounds of oxygen and nitrogen, which comprises supplying successive layers of air to successive electric arcs, in a restricted space in which the reaction takes place, and in extinguishing the arcs by a cooling fluid acting at the outlet from the reaction chamber, the cooling fluid not passing into the said chamber.

1,035,802. PNEUMATICALLY - OPERATED ELEVATOR SIGNAL SYSTEM. BARNEY MEYER, Chicago, Ill.

1,035,804. AIR-COMPRESSOR. MIKE MINTZ, Rock Island, Ill.

1. In an air compressor, the combination with a motor, pumps, a compressed air tank, a diaphragm valve interposed between said pumps and tank, and means for reducing the pressure in the system between the pumps and diaphragm valve to atmospheric regardless of the pressure in the remainder of the system.

AUGUST 20.

1,035,880. VACUUM-PRODUCER. HARRY A. JEFFERY, Cleveland, Ohio.

1,035,955. APPARATUS FOR ELEVATING WATER. NAT H. FREEMAN, Denver, Colo.

1,035,993. AIR-LIFT PUMP. WALTER B. MOORE, Seattle, Wash.

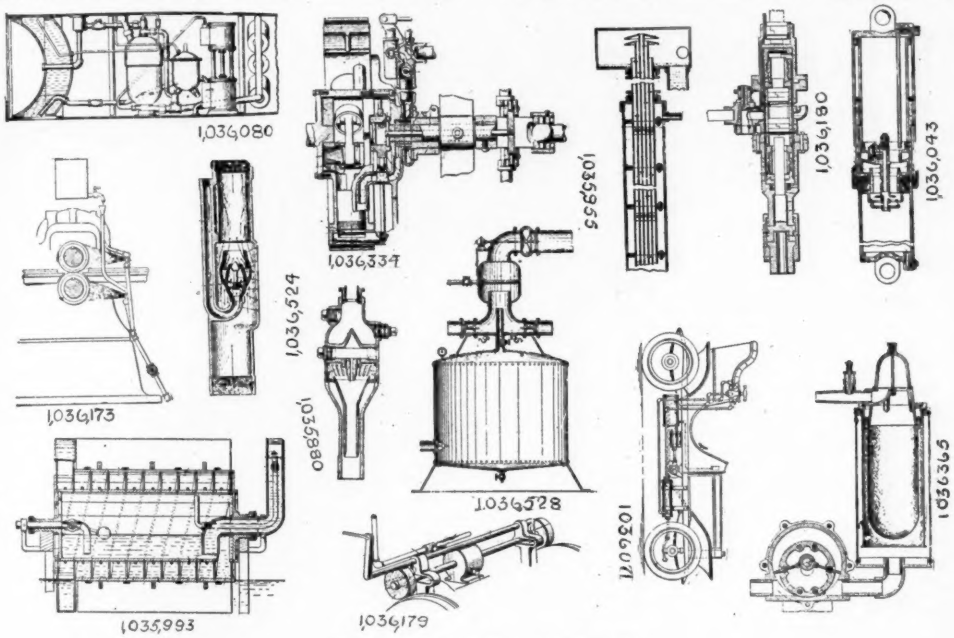
1,036,043. FLUID-PRESSURE DEVICE. GEORGE WESTINGHOUSE, Pittsburgh, Pa.

1,036,071. FLUID - PRESSURE STEERING APPARATUS. EDWARD E. BRYANT, Chicago, Ill.

1,036,080-1-2. APPARATUS FOR GENERATING MOTIVE FLUID FOR AUTOMOBILE TORPEDOES. GREGORY CALDWELL DAVISON, Quincy, Mass.

1,036,173. COOLING AND LUBRICATING APPARATUS FOR DIES AND METAL-WORKING MACHINES. FRED C. AREY, Oak Park, Ill.

1. In combination, co-operating rotary slitting dies arranged one above the other, a work-receiving table lying in advance of the dies to support the work in position to be fed between the dies, an atomizer arranged above the table in position to direct a current against the upper die, a second atomizer located below the table in position to direct a current against the lower die, means for delivering a lubricating material to said atomizers, and means for supplying the atomizers with air under sufficient pressure to cause a considerable lowering in the temperature of the air through adiabatic expansion.



PNEUMATIC PATENTS, AUGUST 20.

1,036,179. AUXILIARY AIR-PUMP FOR LOCOMOTIVE ENGINES. GEORGE A. BOSWORTH, Lincoln, Nebr.

1,036,180. ROCK-DRILL. WILLIAM L. BROOKINS, Telluride, Colo.

1,036,254. PROCESS OF PRESERVING HAMS. PAUL JORN, Hamburg, Germany.

The process of preserving a ham consisting in salting and smoking the said ham, removing the bones therefrom, dipping the ham in boiling water, compressing the ham in a mold of approximately its own shape, partly cooking the ham in the said mold, packing the ham in a can of approximately its own shape, sealing to the can a cover having a vent hole, exhausting the air from the can through the vent hole, hermetically sealing the vent hole, the walls of the can being so weak and the exhaustion of air from the can being carried so far that the pressure of the atmosphere thereon collapses the walls

thereof tightly on to the ham, and finally processing the sealed can.

1,036,334. PNEUMATIC POWER TRANSMISSION. FRANK MONROE PRATHER, Los Angeles, Cal.

1. A driving member, a driven member, cylinders connected with one of said members, pistons in the cylinders and connected with the other member, means including valves for controlling the circulation of air through the cylinders, a storage chamber and check valves opening only upon excessive pressure in the cylinders to place the cylinders in communication with the storage tank.

1,036,340. CUSHIONING DEVICE. ALBERT F. ROCKWELL and CHARLES F. SCHMELZ, Bristol, Conn.

1,036,365. CLEANING APPARATUS. EARL C. STAFFORD, Wilkinsburg, Pa.

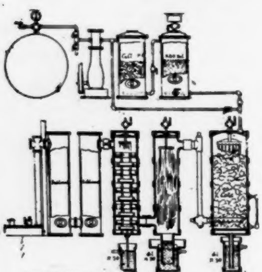
1. In a cleaning machine, the combination of a chamber provided with inlet and outlet ports or openings, depending receptacles having permeable walls arranged in the chamber, one within but separated from the other, the receptacles being so arranged that the inlet port will discharge into the inner receptacle, and means for maintaining a practically uniform flow of air through the chamber and receptacles.

1,036,689. PROCESS OF AND APPARATUS FOR ATOMIZING METALS, ETC. JAMES MILLAR NEIL, Toronto, Ontario, Canada.

1. The herein described process of atomizing metal, etc., consisting in exuding molten metal upwardly through an opening in a flat surface and directing a forcible blast of an atomizing agent against the exuding molten metal so as to first flatten the exuding metal in a film on said surface and then dissipate the metal off said surface, substantially as set forth.

1,036,788. PROCESS OF OBTAINING SUBSTANTIALLY PURE NITROGEN FROM THE AIR. CHARLES BLAGBURN, Antioch, Cal.

1. A continuous process of obtaining substantially pure nitrogen from atmospheric air which consists in causing molten sulfur to flow in a stream, feeding sulfur and supplying air at one end of said stream while restricting the amount of air supplied so that no more oxygen will be present than is sufficient to combine with the sulfur from said stream, compelling the whole of the air to flow, in its whole course, close to the surface of the burning sulfur, conducting away, while confining, the sulfurous acid, unburned sulfur, and nitrogen, depositing the unburned surfur, washing out the sulfurous acid, and collecting the nitrogen, substantially as described.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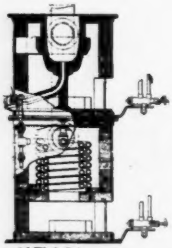
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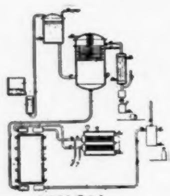
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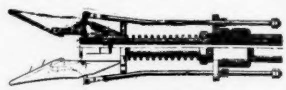
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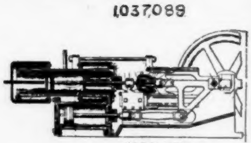
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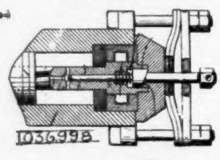
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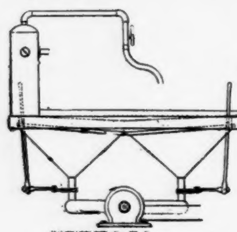
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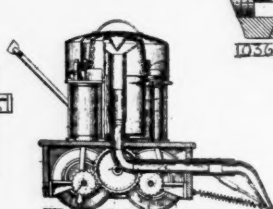
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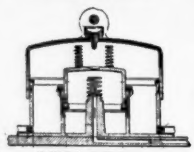
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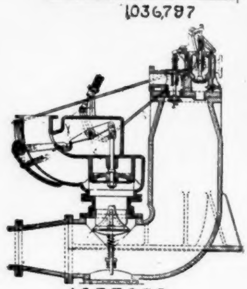
1,037,009

PNEUMATIC PATENTS, AUGUST, 27.

1,036,378. VALVE CONNECTION FOR PNEUMATIC CLEANING SYSTEMS. CHARLES R. THURMAN, Pittsburgh, Pa.

1,036,524. AIR-LIFT PUMP. FRANCIS S. MILLER, Indianapolis, Ind.

1,036,528. APPARATUS FOR COOLING AND REFRIGERATION. OTTO KUPHAL, New York, N. Y.; Helen Kuphal, executrix of said Otto Kuphal, deceased.

1. The combination, with means to direct a blast of expanding compressed air, of a mixing-tube into which said blast is discharged, an evaporator-casing into which said mixing-tube debouches, a spraying device so located with respect to the evaporator-casing and the incoming air-blast as to be in the vacuum produced by such blast, and means for sucking the resulting cooled air from the evaporator-casing.

AUGUST 27.

1,036,627. ROTARY COMPRESSOR. ALBERT HUGUENIN, Zurich, Switzerland.

1,036,656. POWER-PNEUMATIC FOR PLAYER-PIANOS. JOSEPH LEISCH, Tryon, N. C.

1,036,797. AIR OR GAS COMPRESSOR. OLIVER H. CASTLE, Indianapolis, Ind.

1,036,806. PROCESS AND APPARATUS FOR STERILIZING MILK AND OTHER ORGANIC LIQUIDS. JOSEPH DESMAROUX, Paris, France.

1,036,856. PNEUMATIC SHOCK-ABSORBER FOR VEHICLES. GUSTAV KANTER, Murtoa, Victoria, Australia.

1,036,998. FLUID-OPERATED PERCUSSION-TOOL. CHARLES H. HAESELER, Philadelphia, Pa.

1,037,009. METHOD OF RAISING OR FORCING LIQUID. HERBERT A. HUMPHREY and ALBERTO CERASOLI, London, England.

1,037,027. VACUUM-CLEANER. CHARLES A. LINDBERG, Bradford, Pa.

1,037,081. PNEUMATIC CARPET-CLEANER. ROBERT W. THORNE, London, Ontario, Canada.

1,037,083. VALVE FOR VACUUM CLEANING SYSTEMS. CHARLES R. THURMAN, Pittsburgh, Pa.

1,037,089. AUTOMATIC COUPLING FOR AIR-PIPES. CASPER WALERIUS, St. Paul, Minn.